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ANGLO-AMERICAN COLLABORATION FOR DEMOCRACY

DURING last summer, in the early stages of the Battle of Britain, the Prime Minister was reviewing the first year of the War and spoke in homely terms of the English-speaking democracies, the British Empire and the United States, having "to be somewhat mixed up together in some of their affairs for mutual and general advantage"; some time earlier, a manifesto issued on behalf of American men of science, like an earlier resolution of the American Association for the Advancement of Science, had frankly recognized the relation of science to freedom of thought and speech under democratic institutions, and the need for men of science to draw closer together in defence of democracy. The offer of naval bases to the United States, which prompted Mr. Churchill's reference, was only a stage in the development of the association of interests for common purposes between Great Britain and the United States which had already commenced before the War, and which has recently been further recognized by the request from the American Association for the Advancement of Science to the British Association for collaboration in the formulation of an international charter of democracy (see NATURE, April 12, p. 448).

The process which the Prime Minister so warmly welcomed last summer has gathered impetus. In accepting the nomination of the Democratic Convention for election to a third term of office as President of the United States of America, Mr. Roosevelt affirmed the determination of his countrymen to maintain unswervingly in foreign policy sympathy and moral and material support for all free peoples. In subsequent speeches down to the historic speech to the White House Correspondents' Association on March 15, following the passage of the Lease-and-Lend Act, the President has repeatedly indicated how clearly the United States appreciates the great issues which are at stake in the present struggle, and the growing determination of that great democracy to afford not merely sympathy but also the maximum possible support in arms, ships and food which are required by those who now hold the bridgehead of freedom and humanity's hopes.

Nor have Mr. Churchill and President Roosevelt been alone in making it clear, in speeches that have brought the two great democracies closer to each other than ever before in their history, that the two peoples are threatened by the same danger. It was a happy choice that brought a former director of the International Labour Office across the Atlantic to represent the United States in Great Britain, and Mr. Winant's address at the Pilgrims' luncheon has already shown how well qualified he is to interpret the common ideals and basis of our civilization, and to promote that co-operation which in this interdependent world is the only alternative to domination or disaster—the co-operation of free peoples to overcome the fear of domination which has brought so much grief to this generation. It is indeed permissible to see in Mr. Winant's appointment the symbol of American acceptance of a common duty to the world.

Viscount Halifax, in his turn, has given equally happy expression to the Anglo-American unity of

purpose which has been sealed by the passage into law of the Lease-and-Lend Act. This noble interpretation of the principles which are essential to life as we wish to live it and to see it lived, has been as welcome and inspiring on this side of the Atlantic as to those entering on the new and strenuous programme of aid for Britain to whom his words were primarily addressed. Lord Halifax demonstrated the complete agreement of the British Government with the purposes President Roosevelt described with such vivid force in his speech a few days earlier.

There is every reason to believe that, in the pursuit of this common purpose, the two democracies may find a tie that will make them effective reformers and champions of liberty. Nor is this all. Lord Halifax, like Mr. Winant, looks forward to the post-war world: "This business of rebuilding after the War will be a task far beyond the strength of any single country." New needs will demand new remedies, and there will be room alike for all the courage and imagination of youth and all the clear thinking of experience that can be rallied to the task. No tyranny will frustrate the Anglo-American co-operation that is seeking to win a free world, but even more significant for humanity may be the awakening of the two peoples to the immense responsibility that will rest upon them. In the words of Pascal, to "combine justice and power, making what is just strong, and what is strong, just", may deserve and win the support of all other peoples likeminded with ourselves to strengthen the foundations of world society.

The future structure of the community of nations cannot yet be clearly seen. Much indeed may be learnt from a careful study of the past, and it is already clear, from the discussions of the last two years on different proposals for a federal world, that whatever form of co-operation is to succeed must be based on a real community of interests, and on ideals which are widely shared; further, it must command an allegiance which is prepared to make real sacrifices, both individual and corporate, in their defence and service.

It is this that gives particular significance to the three recently published slight volumes*. Dr. Butler's three essays on "True and False Democracy", delivered more than a generation ago, are as full of meaning for Great Britain to-day as when they were delivered in California, in Michigan and in Buffalo. Together they indicate the dangers which democracy has to face in either country, and the great community of democratic institutions which is the heritage of both. We have indeed reason to be grateful that the two nations have leaders and representatives on both sides of the Atlantic who are able to undertake so ably and inspiringly the vital task of education on which Dr. Butler lays his main stress. Prof. J. B. Conant's recent visit to Great Britain has disclosed the extent to which American men of science, as has long been known to their scientific colleagues, are actively with us in our war effort.

Dr. Butler's able analysis of the weakness and strength of democracy leads indeed to the conclusion that, had due attention been paid to such warnings, we should never have had to face the present stern challenge to liberty. It is not the United States alone that has need of an aristocracy of intellect and service. The paucity of genuine thinking and neglect of, or indifference to, electoral and social responsibilities among the citizens of the democracies are among the main reasons for the straits in which we are now placed. Dr. Butler's analysis is more searching than Lord Davies's somewhat bitter indictment of leadership in Great Britain, for an electorate accustomed to think for itself, to face facts and accept responsibilities, would not have been slow to rid itself of incompetent or hesitant leaders. It is the moral basis of democracy that is all-important, and necessitates such untiring attention to the education not merely of public opinion but also of the individual citizen. Without that basis, democracy is indeed effete in the face of the totalitarian regime. From it, as Mrs. Roosevelt shows so clearly in her admirable little book, must come the driving force which will call forth the effort required to establish beyond the threat of force a permanent democracy with its background of spiritual belief.

The great merit of Mrs. Roosevelt's incisive contribution is that it sets forth with admirable lucidity the fundamental issues that are involved in real democracy—the difficulty of achieving a balance between planning and freedom, and the particular challenge to youth, and all that is involved in the acceptance of that challenge and those responsibilities. Democracy, she urges, is a method of government conceived for the development of human beings as a whole, and this dynamic conception involves more than fulfilling our duties

* True and False Democracy. By Nicholas Murray Butler. Pp. xiv+111. (New York: Charles Scribner's Sons, 1940.) 1.25 dollars.
The Moral Basis of Democracy. By Eleanor Roosevelt. Pp. 62. (London: Hodder and Stoughton, Ltd., 1941.) 6d.
Foundations of Victory. By Lord Davies. Pp. 192. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1941.) 2s. 6d. net.

as citizens, seeing that our nation is truly represented by its Government and that the Government is responsive to the will and desires of the people.

That will and desire must be made the result of adequate education and adequate material security. We must maintain a standard of living which makes it possible for the people really to want justice for all, rather than to harbour a secret hope for privileges because they cannot hope for justice. Moreover, from this dynamic conception and practice of democracy, there flow not only a gradual rise in the standard of living of all the people, but also that constant sense of vigilance and alertness which makes life an adventure and gives a continuous appeal.

Mrs. Roosevelt's moving picture of the spiritual values of democracy should enlist the warm sympathy of all forward-looking minds, on both sides of the Atlantic. In itself, her book is evidence of how firm are the moral and spiritual foundations upon which may be built the practical schemes of Anglo-American co-operation to which the last, and perhaps most important and suggestive, chapters of Lord Davies's book are devoted.

The central theme of Lord Davies's book is that this is a civil war against a revolutionary movement seeking to impose a new order upon Europe, and that accordingly victory depends upon diplomatic as well as upon military strategy. It is not even sufficient to direct our efforts to the maintenance of morale in Great Britain. The defeat of the enemy cannot be separated from his defeat in the moral and spiritual arena. It is for this reason that Lord Davies thinks our diplomatic efforts should be concentrated in proclaiming our war aims, in order to secure their acceptance by world opinion. Foreign policy and war aims are an integral part of the strategic plan.

Lord Davies insists that the decisive factors in this struggle are war aims and air power. "The former is the rock upon which our morale, our determination to win, rests. The latter is the instrument through which victory can be achieved." He believes that our supremacy in the air can only be achieved with the active assistance and co-operation of the United States, and that Anglo-American co-operation will win the War because their basic peace aims—the suppression of war and liberation of oppressed peoples—are identical, and because their mastery of the air and command of the sea give them the power to insist upon this new order.

Lord Davies recognizes that the basis of Anglo-American co-operation lies in their heritage of representative institutions. Great Britain is the cradle of representative government, the United States the nursery of federalism. The foundations of a lasting peace are to be discerned in the common ideals, the mutual understanding, identity of interests and closest collaboration of the English-speaking peoples. Already the British and American peoples are closer together than were France and Great Britain when the British Government offered the people of France a permanent union on the basis of a common citizenship. Anglo-American co-operation on a broad front is growing rapidly with the war effort of the English-speaking peoples, and Lord Davies visualizes some form of political union of the English-speaking peoples which would hold the peace during the interval, possibly of several years, between the cessation of hostilities and the summoning of a peace conference to review the settlement. Acceptance of such responsibilities by the two great democracies would afford opportunity for real reconstruction, during and after the transitional period, the development of an abiding settlement and some sort of European order or federation.

Lord Davies looks to the existence of resurgents in the numerous countries under Nazi domination to promote such developments as well as to assist in the physical overthrow of the Nazis in the later stages of the War. He would see our foreign policy directed to exploit these possibilities as actively as possible, and would enlist in an international force the numerous allied contingents at present in Great Britain. We should use to the full every opportunity of explaining as widely as possible our fundamental war aims and purpose.

Lord Davies has written a timely book. It offers a challenge to the intelligence and character, which, as Dr. Butler remarks, a triumphant democracy must possess. Slight as they are in volume, these three books offer no mean contribution to the task of education which is so imperative for the maintenance of morale, and to the consolidation of victory, and to that constructive and creative thinking upon which reconstruction and the evolution of any new world order must ultimately be based. Their appearance at this point is indeed a happy augury that the American and British peoples, acting under the inspiring leadership they now possess, will write a new and more splendid chapter in their own history and in that of the world.

AGRICULTURE IN PRACTICE

Soil and Sense

By Michael Graham. Pp. 274. (London : Faber and Faber, Ltd., 1941.) 7*s*. 6*d*. net.

THIS is a most fascinating and instructive book. Its author lays no claim to be either a farmer or a man of science. Yet this illuminating little treatise on several outstanding aspects of modern husbandry contains much stimulating food for thought for those engaged in, or inclined to embark upon, agricultural pursuits ; and if 'organized common sense' is still a permissible definition of science, it may not unjustly be included among the manuals of science, as applied to our most vital industry.

It is indeed worthy of a wider clientele, especially at a time when the exigencies of war are establishing, through the process of evacuation, unprecedented contacts between our urban and rural populations. It is calculated, in its breezy conversational style and with its homely metaphors, epigrams and maxims, to stimulate the imagination, and evoke the interest, of the veriest Cockney in the attractions and multifarious activities of Britain's countryside. It exhales the pure atmosphere of a fuller life (especially to those of keen observation like the author himself), than material wealth or an urban environment can possibly bestow. For colourful word painting few modern works of practical utility can bear comparison with its earlier chapters. At the same time its useful lessons are expressed in delightfully popular phraseology far removed from the technical jargon which makes so many English agricultural textbooks inexpressibly dull to the layman. It is fertile in appropriate similes provided out of a storehouse of cultured and versatile knowledge. Seldom indeed has a more attractive medium for absorbing the rudiments of an agricultural education, without intellectual effort, seen the light.

Prefacing his first chapter with excerpts from a typical old farm agreement, the author convincingly and mercilessly exposes, by sound scientific reasoning, and without any display of partisan bias or personal prejudice, the dangerous and myopic fallacy of scrapping—under the political watchword "Freedom of Cropping"—the checks upon soil exhaustion imposed by the restrictive covenants in these old documents, and then ploughing in old turf to restore temporarily the productivity of the starved land. Not that he objects to ploughing in turf. Indeed he welcomes it, so long as it is the half-formed turf of a temporary "ley" (or "lea") such as was initiated some fifty years ago on the Holkham estates of the late Lord Leicester, as a modification of the four- or five-course rotation, developed and expounded twenty years later by Mr. R. H. Elliot under the title of "The Clifton Park System of Farming", and in more recent years effectively popularized, through precept and practice, by Sir George Stapledon, director of the Welsh Plant Breeding Station at Aberystwyth. His theme is, in fact, soil fertility, and the manufacture (by organic and other agencies) and maintenance of humus as the basic condition of its availability to plant life. He recognizes, as did so forcibly the late Prof. Henry Armstrong, the lack of phosphates in the average British soil, but questions the wisdom and the economy of applying basic slag or other phosphatic fertilizers, to the extent usually advocated, in order to make good the deficiency. Climatic shortcomings and leaching may, he opines, defeat the object in view. He regards, as Elliot did, continuous doses of artificials and of lime (in the absence of adequate humus) as conducive to soil exhaustion.

His remedy, like Elliot's, is the employment, in "ley" making, of herbage plants of varying depth of root, and especially of chicory and other deep-rooted herbs. It is, he avers, "the solvent action of the knotting of roots that liberates minerals from the large reserves of even the poorest soils". This problem of maintaining humus and soil fertility under modern systems of husbandry (especially now that motor traction has robbed us of much of the animal manure formerly available) and the extent to which chemical fertilizers can provide manurial requirements, is a subject upon which experts are not wholly agreed. This being so, what purports to be the "common sense" view (ably propounded by the author) merits respectful consideration. It is without doubt true that, in the absence of humus or vegetable matter, lime may prove an exhausting agent, even on "sour" soils. In regard to other mineral dressings the exhaustion, if any, is likely to be caused by seriously upsetting the balance of the manurial constituents of the soil. This has been demonstrated in some parts of New Zealand—which has the finest and least adulterated pastures in the world—by excessive applications of nitrogenous fertilizers in areas suffering from serious phosphate starvation. Incidentally, the illustration (on p. 122) of Mr. Graham's book showing the "mining" activities, at different depths, of the roots of different plants (thus assisting soil aeration and the passage of water) is particularly instructive.

There is no doubt that, although less fertilizer is employed by the average small farmer in Great Britain than in many other countries, much money is wasted by those who can least afford it under the mistaken impression that the same medicine, provided by the chemist, is applicable to all soil and plant requirements. Much, too, is applied wastefully to ill-drained, or waterlogged, land. On these subjects the author directs the would-be husbandman along the path of wise discrimination. In connexion with ley-farming—a subject very apposite to war-time food production in Britain—Mr. Graham makes the surprising, but illuminating, statement that "grazing by *bullocks* is an essential part of grass-farming, without which ley-farming may not be successful". "There is no evidence", he says, "that this sort of farming can be carried out successfully without good hard grazing of the leys by mixed stock. The men who have done it have always grazed hard and well. . . . There seems every reason to think that ley farming will be a failure unless keeping store cattle is a success", and he goes on to say "the bullock . . . must be made profitable *somehow*. . . . Our food supply depends on how he eats grass and what he leaves behind him." This is a view that deserves greater consideration than most of our "arable dairying" enthusiasts have yet vouchsafed to it. The puzzle will be to make the fatting bullock a continuously profitable proposition.

No small portion of this book is devoted to an instructive dissertation on grassland, its constituent plants (gramineous, leguminous, and herbal) and their respective peculiarities, seasonal appearance, relative values and manurial needs. He describes cocksfoot as "the king for ley farming"—although of less feeding value than rye-grass—because it has a deeper root system. The selective grazing of animals, particularly horses, is interestingly noted. Too little perhaps, in view of its deep roots and high protein content, is said about lucerne, or alfalfa, the most valuable fodder crop in the world. The penultimate chapter entitled "Britain as one farm" deserves special study under existing war conditions. In it he summarizes the contentions of previous chapters, advocating a more comprehensive planning of the nation's agriculture to supply the nation's needs and a more economic system of utilizing available implements and labour over larger areas than existing farm units.

Among the author's captivating dicta and slogans are the following: "A good tenant is worth more than a high rent"; "the least skilled man on a farm needs more wit than the 'labourers' of other industries"; "Subsidize wages and drop all other subsidies"; "The money should go to good farmers who feed the land, as tradition says it should be fed, and none should go to those who merely exploit it"; and finally "We are surrounded by a world of nonsense, built out of pieces of sense, put together wrongly. This nonsense world has too much chemistry, forgetting the living earth." Perhaps he is right. At any rate the dictum justifies the title of the book.

BLEDISLOE.

GEOLOGY OF COAL

Geology of Coal

By Otto Stutzer. Translated and revised by Adolph C. Noé. Pp. xiii + 461. (Chicago: University of Chicago Press; London: Cambridge University Press, 1940.) 30*s*. net.

THIS volume is largely a translation of Stutzer's well-known work, "Allgemeine Kohlengeologie", but includes a certain amount of revision of the German text by Stutzer himself and much new material, mainly concerning American coalfields, by the late Dr. A. C. Noé, of the University of Chicago. It is designed to supply geologists, mining engineers and others interested in the coal industry, with a full and authoritative account of the many and varied geological problems connected with coal deposits. These are treated broadly in successive chapters dealing with chemical and physical properties of coal, microscopic examination of coal, origin of coal, processing of coal, origin of coal beds, stratigraphy of coal deposits, petrography of coal beds, and disturbances affecting coal beds. Each chapter has its own list of references.

For the first time Stutzer's work is made available in an English translation, and the present edition will certainly find a place on the bookshelves of all who are interested in the geology, mining and technology of coal deposits. The publication of a book of this nature, in which data and illustrations from world-wide sources are brought together, and to the preparation of which a vast amount of research and labour has been devoted, will be widely welcomed by coal geologists as a comprehensive account of the problems in which they are interested. It is alike informative, stimulating and challenging. The general plan of the work seems admirably designed, and with

the help of a detailed table of contents and of adequate indexes to subjects, authors and places, the reader has little difficulty in finding any particular subject or reference he may wish.

It is claimed that in the present edition Stutzer's work has been revised and brought up to date. It would, however, be difficult to justify this claim in its entirety. The chapters dealing with the origin of coal, the origin of coal beds, the stratigraphy of coal deposits and the disturbances affecting coal beds, which together make up approximately half the volume, have no references later than 1935, and only six later than 1930. It is disconcerting to find that the very short chapter (4½ pp.) on the processing of coal is based mainly on a text-book published in Leipzig in 1916. It seems anomalous, again, to find that the only reference to Kidston's researches on the Carboniferous flora is to an early paper of 1885, and British readers will certainly note many other omissions that might well have been included in a work published in 1940. It is a pity, too, that in many cases the information on particular subjects or problems is presented as a series of detached notes rather than as a considered and balanced statement. A compilation of this character cannot be expected to be free from errors, but there are a number for which it is difficult to find a reasonable excuse. The inclusion of a reference to a paper on British Carboniferous stratigraphy in the chapter dealing with the microscopic examination of coal on p. 80, and some very obvious errors on pp. 115, 118 and 366, may be quoted as examples.

These defects, however, can be remedied in any later edition, and certainly the volume now issued is a mine of information on all aspects of coal geology and a notable monument to the patient research and erudition of its authors.

M. MACGREGOR.

CLINICIANS AND BIOCHEMISTS

Biochemistry of Disease

By Prof. Meyer Bodansky and Dr. Oscar Bodansky. Pp. x+684. (New York: The Macmillan Company, 1940). 30*s*. net.

MOST text-books of clinical biochemistry are written chiefly from the biochemist's point of view, and differ little from text-books of biochemistry proper except that practical details are given of the many laboratory tests that have clinical importance. Their arrangement is also biochemical, and it is unlikely that many readers derive much intellectual enlightenment from studying them, apart from those routine clinical biochemists whose job it is to perform these tests.

The book under review is original in that the text is divided up on a clinical-anatomical basis. The successive chapters deal with diseases of the blood, heart, respiratory tract, kidney and urinary tract, digestive tract, liver and biliary tract, pancreas, adrenals, pituitary, thyroid, parathyroids, bone, muscle and male gonads. There are additional chapters on biochemistry in obstetrics and gynæcology, in disorders of nutrition and metabolism and in neurologic and psychiatric disorders. It is apparent that the emphasis is laid on the clinical rather than on the biochemical aspect of the subject. The book is also original in that the treatment of each chapter is theoretical and factual. There are no details of the chemical methods involved in the performance of the various tests; instead are given the normal results of such tests, the findings in the various pathological conditions and an outline of the theories postulated to explain the abnormal results and the cause of the disease. The clinical procedure adopted in performing the tests is generally described.

Such arrangement and treatment has much to recommend it. It is the type of book which usually meets with the criticism of falling between two stools. If this book does so it falls firmly on its feet, and both clinician and biochemist can read it with profit. Each will know a great deal more about the other's problems when they have finished. Biochemistry is still not as fully used as it might be in the hospital ward, and such a book as this, which stimulates interest instead of imparting a mass of practical detail already available in many previous books, or attempting to teach biochemistry to the uninterested medical reader, should do much to make young clinicians appreciate the necessity of the biochemical tests they have done in the laboratory, and may even persuade them to initiate clinical biochemical researches for themselves.

It should be stressed that the book may be *read* rather than studied, since it is written concisely and lucidly with little of the over-attention to detail that is the bane of many American books. For example, the chapter on the pituitary diseases deals only with gigantism and acromegaly, basophilism, dwarfism, cachexia, adiposogenital dystrophy and diabetes insipidus. To those familiar with the multiple classifications adopted by some clinical endocrinologists in Germany and the

United States such a rigid confinement to essentials is very welcome.

The references are well chosen; in general the original paper on any subject is referred to, but only papers of the last ten years are quoted afterwards. All the graphs and tables are taken from original papers. Indications for theoretical reading are apt and full; references to the main review articles by Himsworth, Long, Houssay and Soskin should enable any reader quickly to become conversant with the modern views on diabetes mellitus. The references are also surprisingly up to date. Though most of the work on the chemistry and antihæmorrhagic activity of vitamin K was only done in 1939, the subject is well covered in the book, which is dated March 1940. Such topicality leads one to hope that further editions will be called for at short intervals. Physically the book is well produced, with detailed author and subject indexes, good printing and real binding. The casing adopted by most English publishers is generally quite inadequate to withstand the wear that such books as this may be expected to undergo through constant reference over a period of years.

English readers of American books often seem to find some jarring spelling or syntax offending their pedantic ears. This book compares the size of the pituitary to that of the navy bean. Some future international conference on nomenclature might amuse itself by devising series of internationally recognized nuts, beans, etc., graded according to size for the purposes of such comparisons.

MR. FISHER'S AUTOBIOGRAPHY

An Unfinished Autobiography

By H. A. L. Fisher. Pp. xi + 163 + 4 plates. (London, New York and Toronto: Oxford University Press, 1941). 7*s*. 6*d*. net.

IT was a grievous loss to Oxford and to Great Britain when Mr. Fisher was killed in an accident in London at the beginning of last year. He had written as far as his visit to Canada and New England, and had recovered from the serious breakdown which followed his great work on the history of Europe, which had appeared in a cheap form in 1936 and is a prized book by all who value perfect style and profound knowledge. He had begun to work again with his accustomed vigour and devotion when the accident happened, and we have to add his name to that of the many whom we have lost at this critical time in our history. He would have been a wise counsellor at the many grave moments which have fallen upon us since he passed away. Mrs. Fisher gives in her foreword a touching account of the stream of inquirers and letters which poured into New College in his last years. It was a marvellous life. One can scarcely think of anyone who combined so many activities and performed them all with wisdom and success.

Fisher was born in 1865, and his father, who had studied for the law, was selected by the Prince Consort to be private secretary to his eldest son and spent five years in Court life, always retaining the goodwill and affection of the royal family. On his mother's side he was a Pattle and had through that family both his distinguished appearance and his intimate knowledge of India, with which the Pattles were connected by several branches and various official posts. He thus started high in the social scale, and he widened his knowledge and circle of acquaintanceship by a long stay in Paris after he had finished his course at Winchester and New College. He made two lecturing trips to South Africa and the United States and served on the Indian Public Services Commission (visiting India twice) before he was offered the vice-chancellorship of Sheffield between the years 1913 and 1916. A great deal of public work was interspersed with all this, and it ended in his being asked to join Mr. Lloyd George's Government in December, 1916.

This episode in a marvellous career had almost as many varied experiences as the years which had preceded it. It is too long to describe in detail. The different posts which he was asked to fill at different times in the six years during which he remained with Mr. Lloyd George were the mark of a man of almost infinite capacity, though specially wedded to his first love of knowledge and of modern history. It was as minister of education that he took office and at the Board of Education that he did his chief official work. Secondary education was transformed by the liberal raising of salaries, and a scheme for the extension of the school age with the provision of compulsory continued education from sixteen to eighteen was passed but has not yet been put into force.

Fisher left Sheffield finally in 1918, and the interval from that to the wardenship of New College was filled up with a multitude of useful and always intellectual occupations until the wardenship fell vacant in 1925. New College was his home, study his recreation and the adornment of Oxford his hobby ever since.

It is grievous to think that a casual lorry should have put an end to a life of such rare distinction and of constant service to his fellow-men; yet it is well to be able to think that the best was left to the last. Other men might perhaps have done his public work, though not with the same dignity, good judgment and perseverance. But no one can think of a writer and thinker—for many decades back—who could have produced the "History of Europe". It is practically the history of Western civilization and he had dreamt of it and worked at it during the many toils which took him afield. It is full of learning well-arranged and beautiful to read. If Fisher could have included more science and technology it would be a faultless masterpiece. I know people who make a point of reading some of it every day.

F. S. MARVIN.

STEPS TO AN ISLAND

The Way to an Island

By R. M. Lockley. (Travellers' Tales.) Pp. xi+208+16 plates. (London: J. M. Dent and Sons, Ltd., 1941.) 7*s*. 6*d*. net.

R. M. LOCKLEY has written a number of books dealing with natural history and life on lonely islands, but he has never written a better book than this. I do not mean that there is a greater wealth of accurate observation in this book: I refer rather to the style. The English is admirable; it is simple and direct, very vivid and holding the reader's attention from first page to last. It is indeed a book worthy of the most celebrated masters of modern English prose—Masefield would surely read it with pleasure.

Perhaps, although Mr. Lockley has already written so much on his bird-haunted isle of Skokholm, one could wish that more of this book were devoted to his life on that island. But, as the author says, he has described that life in other books and this work deals with his earlier life—his school days, his intense love of Nature, his dream of owning an island somewhere between Lundy and North Rona, his setbacks and the final fulfilment of his dream.

His description of hearing as a boy the wood warbler's song is admirable (p. 65):

"'See-ee--ee -ee -ee-ee-ee!' cried the wood-warbler in his vibrating voice, and his whole body shivered with delight. A million leaves in the tops of the trees swayed in a rustling chorus which swamped the last sighing notes of the singer. Yes, yes, this is the time we dreamed of in the long wait and coolness of winter, the time of contentment and friendliness and fullest perfection. And with my heart full of a rare joy I waited for the three bell-like notes which concluded the wood warbler's song. They seemed to round off that astonishing magic madrigal by giving utterance to the sadness of replete happiness."

Of his first spring on Skokholm—he had passed the winter in hard work repairing the one house on the island—and his difficulties with the garden the author gives an arresting description. Of the garden he writes (p. 184):

"The garden gave me pleasure and anxious moments by turns. Something like a ton of bracken and nettle and blackberry roots had been removed and burnt, and by degrees I had planted the rich loam with currant and gooseberry cuttings, broad beans, peas, shallots, early potatoes, parsnips, and so on. But rabbits had found a way in more than once, and I had lost some cabbages I had put down. Then with the first mild weather thousands of snails crept from the cracks between the stones in the herring-bone patterned hedge wall. The snails found my tender young stuff excellent after the years of grazing on tough bracken, nettle, and weed. I collected them by the bucketful every evening, and threw them into the sea. I had no help from the birds. All the thrushes had left the island with the coming of spring, and the single blackbird and his mate took no interest in snails."

But success crowned his efforts (p. 188):

"How the plants grew! The marrow-stem kale shot up and opened leaves like miniature banana palms. The corn grew shoulder high. The potatoes were huge. The lines of blue chicory and yellow dandelion gave this field-garden a gay look. The wild rabbits came out every afternoon and inspected the garden from without the wire-netting fence."

From Skokholm the author and his wife sailed out to, and lived for a day or two upon, the still more lonely and remote ocean isle of Grassholm, accessible only in very fine weather when the ocean swell is at rest. Here they watched the gannets at their nesting colony, observed the habits of the grey seals, and slept on the long grass on the east (and comparatively sheltered) side of the island where they could see, across the gannet-haunted miles of ocean, their own island of Skokholm rise on the eastern horizon.

Truly, this is a book to take the thoughts off these grim days of strife, and transport the spirit to admirable and lovely things in the serene world of Nature.

SETON GORDON.

The Photismi de Lumine of Maurolycus

A Chapter in Late Medieval Optics. Translated from the Latin into English by Henry Crew. Pp. xix+134. (New York: The Macmillan Company, 1940.) 15s. net.

"LIGHT concerning Light", the playful title given by Franciscus Maurolycus (1494–1575) to his short text on optics, suggests a certain sense of humour in the author, a prominent churchman and man of science of his day, which might have saved him from the inconsistency of outlook so painfully apparent from the modern point of view in this book. Mr. Henry Crew's charming translation brings within the reach of all a work which is in itself an eloquent comment on the folly of certain chapters in human thinking, especially the kind of thinking which strays over-far from experience and experiment.

As Mr. Crew remarks in his introduction, Euclid furnished the norm for a scientific demonstration throughout the sixteenth century. The assumptions, the data, the theorem and the logical steps to its establishment had to be set out in order. All is well in the early stages, when the law of reflection starts discussion of problems in geometrical optics, and it is even possible to get some distance in theorems regarding refraction, although only the qualitative and not the quantitative law of refraction is known. But when a writer seeks to cast his speculations on the origin of colours, the phenomena of the rainbow, the action of the human eye and the like into the same form, he lays a trap for the ignorant and unwary, who may fail to distinguish the sudden emptiness of speculation from the proper process of thought.

This book, then, makes a re-appearance largely on account of its human interest, though it is a worthy addition to the historical optical literature already available in English. At a time when half the world appears ready to abandon sanity for catch-words and catch notions, anything which by attention to past follies would help mankind to detect its present ones seems like a draught of water in dry weather. The book would make a very suitable present for certain folk of the present day who write pontifically on vast problems with the aid of a little elementary chemistry and biology.

The publishers are to be congratulated on the attractive binding and excellent printing, which make this little book a pleasure to handle. L. C. M.

Quantitative Analysis

By Prof. Harold Simmons Booth and Prof. Vivian Richard Damerell. (International Chemical Series.) Pp. xi+246. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 15s.

IN "Quantitative Analysis" Profs. Booth and Damerell have produced a text-book avowedly for elementary students, but it covers a fairly wide field in its thirty-four chapters. The authors have set out with the intention of impressing upon beginners in analytical chemistry the vital necessity for extreme accuracy. Indeed the clue to the whole tenor of the book is to be found in the introductory chapter where the authors state that "one of the most important requirements for successful experimental work is to be honest with oneself. A high degree of personal integrity is absolutely necessary for lasting success in any science". To ensure that the student will thoroughly digest these truths, the authors have taken the greatest care to give very full details of procedure and explanations of experiments. In fact the wealth of advice, warning and instruction on laboratory technique which normally one learns only by long and often costly experience constitutes a novel feature of this text-book.

The actual experimental work described is confined to the determination of simple elements and radicals and has been selected not with the intention of being exhaustive but with the object of illustrating the basic principles of quantitative analysis. The general theory of gravimetric and volumetric analysis is simply but lucidly explained, and each chapter of the book contains a set of questions whereby the student can subject himself to a "self-examination".

This book can confidently be recommended to beginners in chemistry, and if the student assimilates both the chemical knowledge and the wealth of practical detail contained in the volume, he can scarcely fail to emerge as a most careful and highly qualified analyst.

Select Bibliography of South African Native Life and Problems

Compiled for the Inter-University Committee for African Studies, under the direction of I. Schapera. Pp. xii+250. (London: Oxford University Press, 1941.) 10s. 6d. net.

A "SELECT" biography tends to arouse a certain diffidence, not to say mistrust, in the manner of its reception; but when the material is drawn from a space of four centuries and a literature of the proportions and character of that relating to the natives of South Africa, much weeding is necessary if a practical value is to be secured for anyone who is not already in a great measure expert. The danger of bias, which may be, and indeed often is quite unconscious, has been eliminated in this South African bibliography by calling in the assistance of experts each to be responsible for the department of native studies in which he is an accepted authority, such as, for example, Prof. M. R. Drennan (physical anthropology), or Dr. A. J. Goodwin and Prof. C. van Riet Lowe (archæology) or the Rev. C. M. Doke (linguistics). The editor, whose ability to take an objective and scientific view of native problems has been abundantly demonstrated on many previous occasions, has been responsible not only for the section covering ethnography, both general and tribal, but also for that which deals with the status of the modern native population. It is perhaps unnecessary to comment on the fact that this last-named is the most considerable section in the bibliography, covering 93 pages as against ethnography, 72 pages. The very brief notes following entries, and indicating the scope and character of the item catalogued, will be found helpful and trustworthy by young students.

THE PHYSICAL CONDITION OF THE PLANETS*

BY SIR JAMES JEANS, O.M., F.R.S.

AS the power of telescopes increases the astronomical horizon for ever recedes, drawing many astronomical workers with it, but leaving a few to continue their labours in the older fields. I propose here to discuss some recent work in the oldest field of all—the planets.

The physical condition of a planet depends on many factors, the most important being its distance from the sun. For we have learned in recent years that each planet gives out just about as much light and heat as it receives from the sun, and no more. Thus the planets have but little heat of their own, and are hot only to the extent that they are warmed by the sun.

Yet distance from the sun is not everything. The earth and the moon are at the same distance from the sun, so that their average temperatures are approximately the same, but their physical conditions are widely different. The moon is a dead world in which we see mountains of volcanic rock rising from plains of lava and ash, while the earth teems with life. While the earth's temperature remains fairly steady through the alternations of day and night, that of the moon rushes from one extreme to the other. According to Pettit (1940) the moon's temperature can fall from 101° C. to −117° C. during an eclipse. The change of temperature is far more violent than anything we experience on earth because the moon cannot, like the earth, draw on heat stored in its soil or atmosphere. It has a surface which is probably composed of lava and ash, which are almost perfect non-conductors of heat, and it has no appreciable atmosphere—an inevitable consequence of the smallness of its mass. The earth is strong enough gravitationally to retain the molecules of its atmosphere, while the moon is not.

Bodies of intermediate mass may retain the heavier kinds of molecules, while the lighter escape. For each planet we can calculate which gases are debarred, by their lightness, from appearing in the planet's atmosphere, although to know which actually do appear we must have recourse to observation.

The light by which we see a planet is simply sunlight which has passed twice through the planet's atmosphere—once in going in and once in coming out. These journeys may produce absorption bands in the spectrum of the light, and from these we can deduce the composition of the atmosphere, at least in part. There may also be some loss of light resulting from reflection at the planet's surface, for no substance reflects light perfectly. The proportion of light lost is different for different colours and by comparing the reflecting powers of the surface, colour by colour, with those of known terrestrial substances, it may be possible to identify the material of which the surface consists. Lyot has recently found that both the reflecting powers and the polarizing powers of the surfaces of Mercury, Mars and the moon are all identical with those of lava and pumice. Thus we can scarcely doubt that the surfaces of all these three bodies consist of the products of volcanic eruption in some form or other.

Let us now consider the various planets in turn, commencing with those nearest to the sun.

MERCURY

Nearest to the sun and so hottest of all the planets is Mercury. Just as the moon always presents the same face to the earth, so Mercury always presents the same face to the sun. Thus on one hemisphere of Mercury there is perpetual day—and a very hot day—while on the other hemisphere it is always night—and probably a very cold night. At the point directly under the sun, where it is always noon, the temperature is found to be about 650° F., a temperature at which lead and tin are both liquid.

It is still debatable whether Mercury possesses any considerable atmosphere or not. It is the least massive of all the planets, with only one twenty-second of the substance of the earth, and its power of retaining an atmosphere is small. Under present conditions it would retain oxygen and all heavier gases, but in the past, when it was presumably hotter even than now, all gases except the very heaviest may well have streamed off into space. On the whole its surface markings are so permanent and clear-cut as to suggest that no atmosphere in fact exists. Yet Schiaparelli noticed fifty years ago that some of the surface features were occasionally seen blurred, or even obscured, as though by some sort of cloud, and Antoniadi has recently (1929) confirmed and extended his observations. As the planet could not retain molecules of water vapour, and so must be completely arid, it has been suggested

* From a discourse delivered at the Royal Institution on March 25, 1941.

that the clouds may consist of particles of dust, possibly set free by falls of rock. Even so there must be some sort of atmosphere to save the dust particles from immediately falling back on to the surface of the planet.

VENUS

After Mercury comes Venus, the slightly smaller twin sister of the earth. The small differences of size and mass do not produce any appreciable difference in the atmosphere-retaining capacities of the two planets, and Venus, like the earth, can retain all gases, including hydrogen. Thus if we approach the problem merely in terms of the present state of the planets, we might reasonably expect Venus to exhibit an atmosphere similar to that of the earth, although perhaps somewhat smaller in amount.

Actually the two atmospheres are found to be very different. Something of this difference is suggested by the general appearance of Venus, which presents only a continuous cloud-like surface to our view. Gerasimovič has made a study of the brightness of this cloudy envelope and of the way in which it changes with the phases of the planet, and has shown (1937) that it cannot be gaseous but must consist of large scattering particles—probably products of condensation, like the ice crystals which form the cirrus clouds in our own atmosphere. We have no means of exploring whatever atmosphere there may be below this stratum of clouds, but the "upper atmosphere" above it can of course be examined spectroscopically.

Hydrogen, nitrogen and the inert monatomic gases cannot in any case be detected spectroscopically, but oxygen and most compounds can when present in reasonable amounts. A study of the upper atmosphere of Venus reveals no oxygen and no water vapour, but an abundance of carbon dioxide. This does not necessarily mean that there is no oxygen or water vapour at all, but it means there is very little. If all the oxygen in the earth's atmosphere were collected and spread out in a layer at atmospheric pressure, this layer would be considerably over a mile in thickness, while the carbon dioxide would form a similar layer only a very few feet thick; for the upper atmosphere of Venus, the corresponding thicknesses would be less than six feet of oxygen and more than two miles of carbon dioxide. In brief, carbon dioxide and oxygen change places. Further, St. John found that the total amount of water vapour in the upper atmosphere of Venus is certainly less than that above the highest clouds on earth.

Why should there be so great a difference in the atmospheres surrounding two such similar masses? And why in particular should the oxygen in the earth's atmosphere be free, while that in the atmosphere of Venus is combined with carbon?

As oxygen combines so eagerly with other substances, we might reasonably have expected to find but little free oxygen left in either atmosphere. It has often been suggested that the free oxygen in the earth's atmosphere may be a direct result of the vegetation on the earth's surface; that as this breaks up compounds of oxygen, carbon dioxide in particular, it sets oxygen free in the air. But this can scarcely be the whole story, since primitive life must have required, and found, some free oxygen when it first arrived on earth. Tamman has suggested (1924) that, while the earth was still hot and its solid crust not yet formed, a considerable amount of free oxygen would be produced by the thermal dissociation of water vapour. He calculated that if the whole of the water, ice and snow at present on earth were restored to the temperatures of this epoch, there would be enough water molecules dissociated to provide all the free oxygen at present residing in the earth's atmosphere. The free hydrogen would not, as at present, be retained but would stream off into space. No doubt some of the free oxygen would in due course combine with the solidifying rock of the earth's crust, but vegetation would afterwards come into being to restore the balance. So long as we can postulate both water vapour and vegetation, there will be no great difficulty in accounting for the presence of free oxygen.

If so, there may be no free oxygen on Venus either because there is not enough vegetation, or because there has not been enough water vapour.

As regards the first alternative, we may imagine life to have come to earth as the result of some unusual accident, some rare coincidence, or some special creation, if we prefer. If the corresponding event did not occur on Venus, the whole situation is explained; there is no oxygen, because there is no vegetation. Or it may be that Venus has never cooled down sufficiently for life to appear. There is enough carbon dioxide in the earth's atmosphere to exert a powerful blanketing effect, checking the outward flow of radiation and so keeping the earth considerably warmer than it would otherwise be. The thousand-fold thicker layer on Venus must form a far more potent blanket, and estimates of the temperature of the lower atmosphere of Venus range from about 80° C. to 130° C. Atmospheric pressure on Venus may well be somewhat less than on earth, so that any water that there may be there is likely to exist in the form of steam. If so, Venus must be highly unsuited to life now and must have been even more so in the remote past.

The other possibility, which has been urged by Wildt (1940), is that Venus has always been deficient in water. As Venus and the earth were

almost certainly formed out of the same store of matter—the outer layers of the sun—they would probably start with equal amounts of water vapour. But at a later stage, the smaller mass and higher temperature of Venus may have permitted molecules of water vapour to escape from the atmosphere of Venus, while they were still retained by the earth. If so, any small amount of oxygen set free by thermal dissociation might well be seized by the solidifying rocks, and vegetation could not then come, since there would be insufficient oxygen for it to breathe.

There would also be insufficient oxygen or ozone to screen the atmosphere from the ultra-violet rays of the sun. Wildt accordingly imagines photochemical action occurring on an extensive scale, resulting first in the dissociation of carbon dioxide and whatever water vapour there might be, and afterwards in the formation of formaldehyde (CH_2O) and free oxygen. The free oxygen would continue to combine with the rocks, but the formaldehyde might be expected to remain in the atmosphere. Wildt has accordingly examined Venus spectroscopically for formaldehyde but found none (1940). He states that dry formaldehyde is stable at temperatures higher than about 80° C.; at lower temperatures it polymerizes into a white solid of high but unknown molecular weight. Trautz and Ufer found that the injection of a small amount of water vapour into perfectly dry formaldehyde gas produced masses of dense white cloud. Wildt suggests that the clouds we see on Venus are similar, and so consist of solid particles of hydrates of formaldehyde polymers. According to Auerbach, depolymerization into simple CH_2O molecules does not occur until the temperature exceeds 200° C., a fact which fully explains the failure of Wildt's spectroscopic search for formaldehyde. Wildt thinks it possible that Venus's atmosphere may be entirely depleted of water vapour and its surface covered with particles like those which form its clouds—a sort of formaldehyde snow.

In whatever way it may have originated, we can form a fairly accurate picture of the present state of Venus—a hot dry surface, devoid of vegetation and probably of all life such as we know on earth, surrounded by an atmosphere in which there floats a continuous layer of opaque clouds, which are probably similar in their physical, although not in their chemical, constitution to the cirrus clouds of our own atmosphere.

MARS

Crossing the earth's orbit, we come to planets which are colder than our own. Mars, which comes first, is not enormously colder, its average temperature being about −40° C. Actual temperatures are fairly widely spread about this average, those observed ranging from + 10° C. (summer afternoon on Martian equator) to − 70° C. (polar regions in winter).

The fact that the temperatures are not more widely spread suggests that Mars must be surrounded by a very substantial atmosphere, and observation confirms that this is so. W. H. Wright of Lick Observatory photographed the planet in infra-red light, which penetrates any atmosphere there may be and so photographs the solid body of the planet, and also with ultra-violet light, which has very little penetrating power and so photographs the surface not of the planet but of its atmosphere. He found that the ultra-violet image was measurably larger than the infra-red image, and thus obtained clear proof that Mars has an atmosphere, which he estimated to be from 50 to 60 miles high.

We still know very little of the constitution of this atmosphere. Spectroscopic analysis so far finds no definite evidence of either oxygen, carbon dioxide or water vapour. The rather insensitive test for water vapour merely shows that there cannot be a tenth as much water vapour per square yard as in our own atmosphere.

The two poles of Mars are surrounded by white areas, generally known as "polar ice caps", which diminish in size in warmer weather and disappear almost entirely in summer. They were so named from analogy with the ice-caps on our own planet, but their true nature is probably revealed by the photographs of W. H. Wright, already mentioned. The caps are found to show very clearly in ultra-violet light, but are almost invisible in infra-red light. The only possible inference would seem to be that the caps are merely atmospheric phenomena. They may well consist of clouds of small solid particles, like the clouds which cover the surface of Venus.

The want of oxygen and carbon dioxide in the atmosphere of Mars suggests that this planet also resembles Venus in not possessing vegetation of the kind we know on earth. There are, nevertheless, certain dark areas on the surface of the planet which vary unmistakably, both in colour and extent, as the seasons change. In the past these variations were frequently adduced as evidence of the presence of growing vegetation, but in the light of our present knowledge it seems more reasonable to assign meteorological causes to them—possibly the falling of rain on a desert of volcanic rock or ash.

Thus the general picture we form of Mars is that of a larger and colder moon, which, because of its somewhat greater size and mass, has retained something of an atmosphere, and may still have rains, cloud and fog to vary its appearance.

The Outer Planets

Mars is the last planet on which a solid surface can be seen. Apart from Pluto, about which we know almost nothing, all the planets beyond Mars are much more massive than the earth, and as they are also much colder we should expect them to retain deep atmospheres, as detailed studies make it clear they do.

Wildt estimates that the atmosphere of Jupiter has a depth of 6,000 miles, with an average density of 0·78. For Saturn the figures are 16,000 miles and 0·41, so that the atmosphere occupies more than four-fifths of the whole volume of the planet.

The greater part of both atmospheres will be at a pressure of more than a million terrestrial atmospheres. Under such pressures, no known substance remains gaseous, so that what we have called the "atmospheres" of these planets must mainly consist of solids and liquids. Also, under such pressures, most substances become denser than water; the principal exceptions are hydrogen, helium, methane (CH_4), ethane (C_2H_6) and ammonia (NH_3). The low density of the "atmospheres" of Jupiter and Saturn suggests that they must consist largely of these substances. Hydrogen and helium, which it is not possible to detect by spectroscopic means, probably figure largely in both atmospheres, because they are abundant in the outer layers of the sun; both planets have ample gravitational power to retain them with ease, even at very high temperatures. The only substances which spectroscopic examination discloses are methane, which occurs in profusion, and ammonia, which is not found to occur in any great quantity. It is remarkable that these two gases account for absolutely the whole of the absorption of light observed in the atmospheres of Jupiter and Saturn. If other constituents are present, they are either in amounts too small to be observed or else, like hydrogen and helium, make no spectroscopic impression on light passing through them.

Still farther away from the sun come Uranus and Neptune, which prove to be merely colder miniatures of Jupiter and Saturn. The observed temperature of Jupiter is − 138° C. and of Saturn − 153° C.; the temperature of Uranus is certainly lower than − 183° C. and that of Neptune probably lower still, perhaps about − 210° C.

In their general structure the two planets are clearly similar to Jupiter and Saturn; the spectra of their atmospheres are also similar, both showing a great abundance of methane, although ammonia has not yet been detected—possibly the extreme cold has frozen it out.

We can now try to form a physical picture of the system of planets as a whole. Leaving out Pluto, because we know nothing about it, and reserving Venus and the earth for later discussion, we see a sequence of planets—Mercury, Mars, Jupiter, Saturn, Uranus and Neptune—in which the physical conditions vary continuously as we pass along the sequence. We find heat giving place to cold, absolute aridity to an abundance of water or ice, while the atmospheres increase in depth and extent and hydrogen probably increases from nil to a large amount, existing in the form either of free hydrogen or of its compounds, especially methane.

The reason why the twin planets, Venus and the earth, do not altogether fit into this sequence is in part because they are more massive than their immediate neighbours Mercury and Mars, and so retain more atmosphere. After allowing for this, Venus fits into the sequence fairly well, but the earth still remains anomalous in having so much oxygen and water vapour in its atmosphere. This is probably a consequence of its clothing of vegetation; life has come to the earth and thrown it out of its place in the regular sequence.

Not long ago it used to be thought that the sun was continually cooling and the planets with it. What the earth now is, it used to be said, Mars must have been in the not very remote past and Venus will be in the not very remote future. If the earth is the only planet on which life now exists, Mars may nevertheless be the planet of spent life and Venus the planet of life yet to come. Our recently acquired knowledge of stellar structure and stellar evolution requires a substantial modification of this view. The sun obtains its energy from subatomic re-arrangement of its substance, light elements combining to form heavy ones, but so long as the supply of light elements does not give out entirely, the effect of these chemical changes on the sun's mechanical structure and on its outpouring of energy is extremely slight. Thus Mars must have had its present chilly temperature since those remote days when it was still warmed by the heat it had brought from the sun, and Venus will retain its present heat until the sun's supply of light elements becomes used up and it collapses into a cooler and smaller "white dwarf". This being so, the idea that life can progress along the planetary sequence is probably illusory. The earth is the planet of life because it is at the right distance from the sun, but there is no justification for thinking either that life of the kind we know on earth once existed on Mars or that it will in due course appear on Venus; these planets are at the wrong distance from the sun.

INDUSTRIES OF THE CROMER FOREST BED

BY J. REID MOIR, F.R.S.

CLEMENT REID, in his well-known description of the deposits of the Cromer Forest Bed in Norfolk, states[1]: "Both the fauna and flora, leaving out the large mammals and other extinct forms, are curiously like that of the 'Broad District' of Norfolk at the present day; and this, like the rest of the evidence, points to a wide alluvial plain with lakes and sluggish streams, bounded on the west by a slightly higher sandy country covered with fir-forests and distant from any hills." The climate of this pleasant hunting country, now obliterated by the North Sea and great thicknesses of glacial deposits, was evidently genial, and we may suppose very suitable for the primitive people inhabiting the region in those remote days. It is, in fact, somewhat difficult to imagine a terrain, rich in wood, flint of first-class quality, and big game, more suitable for the successful activities of the men of the Old Stone Age, and researches carried out in recent years have demonstrated that a succession of races of these people lived in the valley of the ancient Rhine.

Some years ago, I was able to establish that five different periods of human flaking on flints were present in the Suffolk Bone Bed beneath the Red Crag of Suffolk[2], thus extending very considerably the duration of man's existence in the Pliocene epoch. Now I am able to announce that no less than *seven* periods of artificial flaking of flints are present in the basal layer of the Cromer Forest Bed. This, if my conclusions are found to be accurate, means that the duration of man's existence in the Early Pleistocene epoch must also be extended considerably.

The manner in which it is possible to distinguish different periods of flaking upon flints is quite simple, and in most cases irrefutable. A flint implement in the course of time—almost certainly prolonged—has, under natural conditions, become patinated and stained. Its flake scars exhibit a very definite coloration—for example, a dark mahogany brown—and at one or more places this flaking has been cut into by later fractures and these may be of a white, blue or other colour. When, moreover, it is found that the deposit under examination contains assemblages of flint implements differing from each other in their morphological details, and exhibiting patinations comparable with those observed upon the re-flaked specimens, it is evident that we are dealing with artefacts of different ages, made by a succession of races of prehistoric people. The various groups of implements discovered in the Suffolk Bone Bed at one time lay either on, or in, a pre-Crag land surface which was broken up and redeposited by marine action, and in the case of the basal layer of the Cromer Forest Bed, now to be considered, a comparable explanation is postulated.

At certain sites along the north-east coast of Norfolk, this basal layer is exposed either at the foot of the cliffs or upon the foreshore at low tide. The deposit is a very hard ferruginous bed composed of sand, large numbers of flints, and in places marine shells and the remains of terrestrial mammals. Where the bed is present upon the foreshore, it is gradually broken up by wave-action, which washes away the sand matrix and leaves the harder constituents—flints, bones, etc.—upon the underlying surface of chalk.

It is from the large 'sporads' of flints thus formed that considerable numbers of artefacts have been recovered, but many other comparable specimens have been found in the basal layer where it is *in situ* and undisturbed. The seven groups of humanly flaked flints discovered in the basal layer of the Cromer Forest Bed may be described, briefly, as follows:

(1) Specimens exhibiting either a purplish colour with chestnut brown areas, or the well-known 'blacklead' patination. The predominant form is a coarsely flaked hand-axe. Rostrocarinates occur and many striking examples of transitional rostrate hand-axes. There are also racloirs, choppers, scrapers, and points. The specimens tend to be massive in size and are often severely striated and abraded.

(2) Reddish-brown specimens composed largely of flakes of considerable size showing prominent bulks of percussion, and when present, flat striking platforms. A few large core pieces and some borers and scrapers. Flints very seldom exhibit striations, or the amount of abrasion seen on the specimens of Group 1. Hand-axes and rostrocarinates are very rare.

(3) Ochreous-yellow specimens almost entirely composed of flakes generally less in size than those of Group 2 and exhibiting smaller bulbs of percussion. A few racloirs and scrapers. Striation negligible and little abraded.

(4) A small series of greenish-yellow specimens comprising steep-faced scrapers and points. Flakes very rare. Flints exhibit no striations but some signs of rolling.

(5) Specimens of a cream or white colour.

Numerous flakes usually exhibiting small bulbs of percussion. Some fine racloirs, broad scrapers and points. One racloir shows two adjacent bulbs of percussion, and the cutting edge formed by 'resolved' flaking. Some striations but little abrasion.

(6) Blue flakes, some showing signs of use, tending to be large with some well-formed bulbs of percussion. No striations or abrasion.

(7) Black, unchanged flakes, some showing signs of use, and smallish bulbs of percussion. No striations or abrasion.

The above groups are arranged in what appears to be their respective ages as shown by the re-flaked specimens and indicate that in Early Pleistocene times an industry rich in primitive hand-axes, rostrocarinates and transitional forms was followed by a succession of what must be regarded, on the evidence at present available, as flake industries in which core implements are, to all intents and purposes, absent. The presence of hand-axes in Group 1 makes it advisable to refer all these industries to early Palæolithic times, while those in the more ancient Bone Bed of Suffolk, which differ very markedly in many respects from the Forest Bed artefacts, and in which hand-axes are of an exceeding rarity, are to be relegated to the Eolithic period.

In the Estuarine Bed above the basal layer of the Cromer Forest Bed a few artefacts have been found, chiefly by Mr. J. E. Sainty, who has given me invaluable help in my investigations. These specimens are of somewhat primitive types and their flake-scars exhibit, usually, a shiny black coloration, and are derivatives in the Estuarine Bed. The Upper Freshwater Bed, above the latter accumulation, has, so far, yielded no recognizable flint artefacts. A representative series of the Cromer Forest Bed industries has been arranged in Ipswich Museum. The research was carried out under the auspices of the Royal Society and the Percy Sladen Memorial Fund.

[1] "The Geology of the Country Around Cromer" *Mem. Geol. Survey* p. 61.
[2] *J. Roy. Anthrop. Inst.*, July–December 1921.

CHEMICAL SUBSTITUTES FOR DIETARY PROTEIN

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Introduction

UNDER present war-time conditions the protein supply of the nation is of paramount importance. The problem of finding substitutes for dietary protein, therefore, in the form of simple nitrogenous compounds of a non-protein nature, capable of industrial synthesis, opens up new possibilities in war-time economy. The aim of this discussion is to show that this problem has reached a practical stage.

Experiments have been carried out over a period of years in various countries, investigating the effect of urea, ammonium acetate, ammonium bicarbonate, glycine, asparagine, succinamide, and other similar substances. These experiments were designed to ascertain the result of this 'amide' substitution on :

(*A*) Dairy cattle and goats (for milk production).
(*B*) Heifers, bullocks, etc. (for meat production).
(*C*) Sheep (for meat and wool production).
(*D*) Humans.

The above were all practical feeding experiments. Another series of experiments attempted to discover the mechanism by which protein substitution is brought about.

(*A*) Dairy Cattle and Goats (for Milk Production)

Ziemer and Ehrenberg fed goats and milk cows with ammonium bicarbonate in conjunction with acid sugar beet slices, sour whey, and silage (that is, with the ammonium salts of the organic acids present in these feeding stuffs), replacing protein nitrogen by equivalent amounts of ammonia. Extra starch was given to make up the calorific value of the ammonium bicarbonate.

With goats ammonium bicarbonate was able to replace 50 per cent of the food protein for milk production. With milk cows up to 76 per cent of the production protein could be replaced by equivalent amounts of ammonium bicarbonate, which, whilst not reaching completely the effect of good oil-cake food, proved a satisfactory substitute, provided that it was fed in conjunction with a suitable commercial or home-grown starch supplement. However, the extent to which ammonium bicarbonate was utilized was influenced largely by the individuality of the animals ; cows with more than three gallons milk yield not responding very well to the ammonia feeding. The composition of the milk remained perfectly normal in the ammonia-fed animals.

Similar experiments with urea and glycine showed that, in terms of milk production (4 per cent fat content), the efficiency of urea and glycine was about 40 per cent and 30 per cent respectively that of the oil-cake.

Richter and Herbst, also working with urea and glycine, obtained a reduction in milk yield when the replacement of production protein by 'amides' reached 50 per cent.

Eventually mass experiments were conducted by the German *Forschungsdienst*, according to a common experimental plan, in which the protein demand for about two gallons of milk was covered by 'amides'. In general, the 'amides' were found to possess half the efficiency of protein. Therefore a *Wertigkeit* (complementary value) of 50 was allotted to the urea nitrogen. These results led finally to the commercial manufacture of the amide oil-cake mixed concentrate (*Amidoelkuchen-mischfutter*) by the German I.G.

(*B*) Cattle (for Meat Production)

In experiments by Fingerling *et al.*, two nine-months-old bullocks had the gluten of their production ration replaced by equivalent amounts of urea, with the result that nearly the same nitrogen-balance was obtained as before. The relative retentions of gluten and urea nitrogen in the total protein, expressed as a percentage of the total nitrogen absorbed, were calculated as 61·7 per cent and 55·8 per cent respectively. When during a subsequent period only the minimum maintenance protein was fed, a sharp drop in the nitrogen retention occurred, proving that the amount of nitrogen retained in the urea period could not have been due to the maintenance protein. The authors, therefore, conclude that the nitrogen of urea can be utilized within fairly wide limits by the growing animal. Hence, they advocate the introduction of urea as a protein substitute into agricultural practice.

Bartlett and Cotton at Reading tested the effect of urea on dairy heifers 7–12 months old by replacing one-third of the protein ration with the 'amide'. Body measurements, handling properties, fatness etc., were observed. No significant differences were found between the 'amide' fed and protein fed animals. With regard to live-weight increases the conclusion was reached that animals receiving nitrogen over and above the low protein level in the form of protein showed better live-weight gains than those receiving the same quantity in the form of urea. The differences, however, were statistically not significant.

In a Rhodesian experiment, by Murray and Romyn, the live-weight increases of Red Poll heifers over a period of ninety-three days was found to be approximately the same by feeding equivalent amounts of urea as by feeding peanut cake.

In America, Hart, Deobald and Bohstedt experimented with four calves, the first receiving a low protein ration, and the others getting the same feed plus urea in the second, ammonium bicarbonate in the third, and casein in the case of the fourth calf. The live-weight gains were 65, 105, 110 and 126 lb. respectively, again confirming a considerable utilization of 'amides'.

(*C*) Sheep (for Meat and Wool Production)

Among the more recent experiments in this field there are the investigations with growing lambs by Nehring and Schramm, who replaced one-third of the total nitrogen by urea, glycine and ammonium acetate respectively. Whilst the nitrogen-balances were negative in the basal and low protein periods, they became positive in the 'amide' periods, reaching a maximum with ammonium acetate.

In this connexion mention should be made of various criticisms advanced by some workers against these positive results. For example, the question of excretion of ammonia via the lungs and intestinal gases has been raised. This was investigated by Nehring and Schramm, by Scheunert and by Sauer, with absolutely negative results. Further, the possibility of a mere *flooding* of the blood and organs by the 'amides' has been suggested. This criticism was based on increases in 'rest' nitrogen in the blood of 'amide' fed animals. But whilst these increases amounted to one or two grams over a period of *several weeks*, there was a *daily* nitrogen retention of 2–3 gm.

Nehring and Schramm also tested the effect of dried beet slices plus urea, and of molassed bran plus urea, as part of the previously mentioned German mass experiments. The conclusions were:

(1) The experiments with the two preparations showed that up to 200 gm. of urea per day could be fed without any ill-effects.

(2) The digestibility of the two feeding stuffs was very high, and apart from the urea it was 82 per cent and 85 per cent respectively.

(3) The feeding of the two 'amide' preparations caused an improvement in the nitrogen-balance. As compared with the basal period with hay there was a retention of 2–3 gm. of N. more in the slices, and 1 gm. more in the bran.

Very similar results were obtained by Mangold and Stotz, who experimented with linseed cake plus urea, and with potato flakes plus urea. The percentage of urea in both preparations was about 15 per cent.

Further, Liliencron, feeding glycine to lambs for 150 days, obtained very satisfactory results. Similarly, Kirsch and Sauer, studying the effect of different 'amides' on growing sheep, when 20-30 per cent of the nitrogen was replaced, found no differences between the normal and urea groups

with regard to live-weight gain and wool production.

The most conclusive experiment of all, however, was reported by Nehring and Schramm in 1939. Four groups of animals were used. In one, protein was fed in adequate amounts (normal group), in the second, one-third of the crude protein or one-half of the digestible crude protein was left out (deficient group), and in the third and fourth groups this one-third was replaced by equivalent amounts of urea and glycine (amide groups).

This is the first experiment in which both nitrogen-balances and live-weight gains were recorded and related to each other by recalculating the nitrogen retention into live-weight gains with very good agreement. The sulphur-balances, following closely the result of the nitrogen-balances, confirmed the anabolic utilization of the nitrogen retained.

The results can be summarized in the accompanying table :

	Groups			
	Normal	Deficient	Urea	Glycine
N retention in gm./day ..	4·87	3·13	4·86	4·90
S " " " ..	0·519	0·342	0·379	0·432
Daily live-weight gain in gm.	102·5	75·4	93·0	101·0
Live-weight gain minus wool increase in gm./day ..	93·2	63·8	82·8	89·6
Live-weight gain calculated from N retention minus wool N in gm./day	100·1	53·8	97·2	99·4

These results of the nitrogen investigations, supported by the determination of the sulphur-balance and related to the results of live-weight gains, are regarded as proof that 'amide'-like substances like urea and glycine can be utilized in the growing ruminant under certain conditions in place of protein for the production of new body substance.

Experiments, which gave negative results, but which were in the author's opinion invalidated by various flaws, have been omitted for the sake of brevity.

(*D*) Humans

Whilst in the ruminant a definite retention of non-protein nitrogenous compounds has been established, the question of a retention of non-protein nitrogen in the human is completely unsettled, and although results hitherto obtained are contradictory and inconclusive, they seem to point to a negative answer. This agrees with the evidence on the mechanism of non-protein nitrogen utilization, put forward in the next section.

Influence of Micro-organisms

As far back as 1843 the view was expressed that Infusoria might have a special nutritional significance. Later, Pasteur and A. Mayer succeeded in forming protein of micro-organisms in yeast moulds from ammonia. These results were confirmed by M. Mueller with asparagine and ammonium hydrogen tartrate, by showing that rumen bacteria prefer these substances to protein for anabolic purposes, thereby producing considerable quantities of protein. Zuntz interpreted these results by assuming that 'amides' could be used by the ruminant by way of assimilation by bacteria in the rumen, and their subsequent digestion in the truly enzymatic digestive tract (Zuntz's bacteria hypothesis).

In 1920, on the basis of extensive experiments, Voeltz concluded that urea can assume the role of food protein in the metabolism of the ruminant, whereby urea is first built up into bacterial protein in the digestive tract, 80–90 per cent of which is afterwards absorbed from the intestines.

The first quantitative data on the problem were supplied by Schwarz, who found that the nitrogen of the bacteria and infusoria accounted for 11·7 and 20 per cent respectively of the total nitrogen content of the rumen. He calculated the weight of micro-organisms per 100 kgm. rumen content as 2·79 kgm., which contains 41 gm. of nitrogen, corresponding to 256 *gm. of protein*, 80–90 per cent of which can be utilized, according to Voeltz. The protein requirement of the ruminant, however, is put at 0·6 lb. per 1,000 lb. live-weight, corresponding to 272 *gm. of protein*. There is, therefore, stored in the micro-organisms a sufficient amount of protein for covering the protein requirement of the animal. Unfortunately, the crucial point, whether there is an increase in the micro-organic nitrogen of the rumen during 'amide' feeding has never, to my knowledge, been *directly* investigated.

With regard to the question of the subsequent digestion of the bacterial protein formed in the rumen, Bruner showed that a glycerol extract of pancreas, containing trypsin, dissolves Gram-negative, but not Gram-positive bacteria. Pepsin, amylase and lipase show no distinct effects on the two groups of bacteria. Therefore it seems possible that not only does the bacterial synthesis in the rumen depend on variable conditions, but that also the bacterial protein thus formed can be digested to a variable degree by the digestive enzymes.

Research into the creation of favourable conditions for protein synthesis is, therefore, *imperative*. It is obviously necessary to influence the activities of the rumen micro-organisms, so that within natural limits protein bricks of all necessary kinds in the right proportions are manufactured in order to ensure the synthesis of a corresponding amount of milk, meat, wool, etc. This is clearly linked up with the whole question of protein make-up, biological values, etc.

Very interesting are the results of Klein and his co-workers, who on the basis of the results of metabolism experiments and from the mycological and metabolic changes of the rumen paste and of the fæces, concluded, that in certain protein-

deficient combinations in the rumen, protein can be synthesized from the nitrogenous fractions of 'molasses-amides'.

A further contribution in this connexion are the experiments by Lenkeit and Becker on the fate of the urea of 'amide-flakes' in the rumen. Two series of experiments were carried out, one *in vivo* and one *in vitro*. In the former, the decomposition of urea into ammonia and carbon dioxide was instantaneous, but in the latter, working with rumen extracts, it could be followed analytically. There was a progressive decrease of urea nitrogen and increase of ammonia nitrogen, leading to the complete decomposition of the urea after twenty-four hours. *But* 10–20 *per cent of the original urea nitrogen does not appear in the form of ammonia.* The explanation of this fact probably lies in the fixation of ammonia nitrogen in the metabolism of the animal or in the micro-organisms present.

Conclusion

This whole problem of 'amide' substitution is, therefore, a very important one, especially in present war-time conditions, although it might even be considered in peace-time as a means of reducing the cost of the most expensive constituent of the production ration, namely, protein.

Under war-time conditions it appears essential to be able to feed for production purposes with substances which can be produced synthetically at home at a reasonable price. These 'amides' have, however, to be fed in conjunction with suitable foods. This problem has already been largely solved in Germany, where four preparations are manufactured industrially :

(1) Dried beet slices with urea solution.
(2) Molassed bran with addition of urea.
(3) Linseed meal with urea.
(4) Potato flakes with urea.

In this connexion the following suggestions are offered :

(1) We in Great Britain could make immediate use of all the results of the German experiments, without going through the tedious processes through which they have gone.

(2) Although it took a war to impress the importance of silage-making upon the British farmer, in the case of 'amide' substitutes he would just receive the ready-made feeding-stuffs (like any other cake) from industry, and therefore the inertia of the farmer would be more easily overcome than in the case of silage, which he has to produce on his own farm.

(3) Ammonium salts can be fed in conjunction with silage, a fact very significant in view of the introduction of silos on to many British farms.

(4) It should be the task of the industrial chemist to find cheap methods of synthesizing the various 'amides'.

(5) Bacteriological research should ascertain the optimum conditions for protein synthesis in the rumen, as well as find the particular groups of bacteria best suited for the purpose. The synthetic feeding stuffs could then be *inoculated* with these strains, and thus it might be found possible to feed even more concentrated 'amide' foods than the Germans were able to use. That this idea is a very practicable one is shown by the opinion, expressed by many workers, that the bacterial activities in the rumen occur first and foremost under the influence of bacteria *ingested from the outside*.

(6) The enormous saving in shipping space which could be attained by the use of synthetic 'amide' foods should be strongly emphasized. Even assuming the complementary value of 'amides' to be only 50 per cent, a 50 per cent reduction in shipping space would be effected, since, instead of 100 parts of cake, 50 parts of 'amides' plus 50 parts of cake could be fed.

We have, therefore, in this problem a unique opportunity for the industrial chemist, the theoretical scientist, that is, biochemist and bacteriologist *and* the practical agriculturist, that is, stock-feeder and dairyman, to co-operate in the solution of a problem which is vital for the feeding of the nation, and therefore for the successful prosecution of the War.

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OBITUARIES

Sir Frederick Banting, K.B.E., F.R.S.

MAJOR SIR FREDERICK BANTING died in Newfoundland on February 21. He was on his way to England "on a mission", as the Prime Minister of Canada has said, "of high national and scientific importance". The pilot of the American bomber in which Banting was flying attempted a forced landing after the development of trouble with the engines, and in the resulting crash Banting and two of the crew members received injuries which proved to be fatal. In his death the Empire has lost one of its most distinguished citizens and the human race one of the greatest benefactors of our time. Canada could ill afford to lose him. There was no more important figure than his in our general war effort.

Frederick Grant Banting was born in Alliston, Ontario, on November 14, 1891, of Irish and Scottish ancestry. After receiving his preliminary education in the public and high schools of Alliston, he began his medical course at the University of Toronto in 1912. He enlisted as a private soldier in 1915, but was ordered back to finish his university training. He completed his medical course in 1916 and immediately joined the Canadian Army Medical Corps. He proceeded to France and was wounded at Cambrai in September 1918. He received the Military Cross for valorous conduct during the Cambrai engagement.

In 1919 and 1920 Banting served as resident surgeon in the Hospital for Sick Children, Toronto. He then moved to London, Ontario, where he began to build up a practice. He spent part of his time as research assistant in the Department of Physiology of the University of Western Ontario. In the course of the preparation of a lecture on diabetes the idea which was to change the course of his life presented itself. Banting was determined that this idea should receive an adequate trial and on the advice of his associates interviewed Prof. J. J. R. Macleod in the University of Toronto. In his lectures on carbohydrate metabolism to his senior students during the academic session of 1920–21, Prof. Macleod outlined Banting's hypothesis, and while he fully appreciated the difficulties of such an investigation he did feel that adequate opportunities for a trial should be provided. The work was begun on May 16, 1921, in collaboration with myself. The actual results of the experiments are recorded in our notebooks and in our published articles; but the memories of that intimate association during the spring, summer and autumn in 1921 are now difficult to describe. Banting was always happiest when the investigations demanded great mental and physical activity. In these circumstances the days were always too short and continuous observations for several days and nights were not infrequently made. There is no doubt that his dogged perseverance was a highly important factor in the success which attended the insulin investigations. Banting always retained that freshness of mind and modesty of bearing which characterized him when he was conducting his first researches. These qualities were blended with an iron determination and an exceptional measure of courage to produce a character which will be vividly remembered by all who knew him intimately.

After the discovery of insulin a great many pathways were open to Banting. He would have had no difficulty in becoming a successful diabetic specialist. He often mentioned the possibility that he would return to the practice of surgery. Many institutions placed their facilities at his disposal, but he was steadfast in his determination to remain in Canada and probably always intended to spend at least a part of his time in medical research. His active interest in the clinical applications of insulin was shortlived and he soon turned his attention whole-heartedly to physiological problems. He did excellent work while investigating the functions of the suprarenal cortex and in several other intensive studies. It is greatly to his credit that after the initial dramatic discovery he was able to content himself for prolonged periods with programmes of research which promised no immediate results of practical value.

Banting directed and actively participated in cancer research for many years, and he was very proud when the experts in this field stated that his group was making a substantial contribution. Nothing gave him greater pleasure than to spend his time in experimental work which demanded his full attention. He often regretted that he could not spend more of his time in this way.

Banting was probably one of the few medical men of science in the Empire who actually made preparations for war researches well before the outbreak of hostilities. He was almost entirely responsible for the inception and organization of the researches in aviation medicine which have been carried out under the auspices of the National Research Council of Canada. His energy and enthusiasm in this work knew no bounds. He demonstrated an organizing ability which astonished even his intimate friends. Canada's war activities along medical lines owe much to the stimulus which it has received from Banting's efforts. It is probable that his last work will rank among his greatest achievements.

Banting appreciated deeply the honours which were showered upon him, but nothing diverted him from the development of medical research in Canada. He thoroughly enjoyed vacations, during which he was able to give scope to his talent for transferring the beauties of the Canadian landscape to canvas, but these periods away from his laboratory were always short. He had gathered around him a group of active young workers whose efforts have already been rewarded by a considerable measure of success. Their chief was keenly aware of all the difficulties in the problems which he asked them to attack. He

was inclined to be intolerant of those who favoured the leisurely approach and felt that a research worker should throw himself heart and soul into the struggle. His philosophy of life was that men are prevented from reaching their goal by their inability to "think and work hard enough and long enough".

During the last few years Banting had the opportunity of becoming intimately acquainted with most of the active workers in medical research in Canada and of studying their methods in their laboratories. His passionate devotion to the open-minded experimental approach to medical problems and his ability to communicate his enthusiasm to other people will be dominant factors in the development of this work in Canada for many years to come.

C. H. BEST.

Dr. J. Rendel Harris

WE regret to record the death of Dr. J. Rendel Harris, Biblical scholar, archæologist and orientalist, which took place at Selly Oak, Birmingham, on March 1 at the age of eighty-eight years.

James Rendel Harris was born in 1852 and educated at Weymouth Grammar School and Clare College, Cambridge, of which he became a fellow and lecturer after he had graduated as Third Wrangler in 1874. Although a mathematician—he served as moderator and examiner in the Mathematical Tripos—he turned to Biblical and patristic studies, to which he became ardently devoted, rapidly attaining an outstanding position in textual criticism. In 1882 he left Cambridge for the United States, where he remained for some years, holding the chair of New Testament Greek in Johns Hopkins University, Baltimore, and later that of Biblical languages at Haverford College, Pennsylvania.

In 1893, Harris returned to Cambridge, and for ten years he was University lecturer in palæography, travelling extensively the while in the East in search of manuscripts. His success in this field of research, combined with his profound scholarship, bore fruit in notable and lasting contributions to Biblical and Syriac studies. After a brief tenure of the professorial chair of theology at Leyden he became director of studies at the Settlement for Social and Religious Studies of the Society of Friends at Woodbrooke, near Birmingham.

At Woodbrooke, Harris continued his studies in Syriac, but turned in an increasing degree to research in anthropology and folk-lore, devoting himself more particularly to the examination of early Mediterranean cults and their relation to forms of popular and other beliefs in the Christian Church. In "The Cult of the Heavenly Twins" (1906) and "Boanerges" (1913), the former dealing with the legend of the Dioscuri, he showed, with a wealth of comparative illustration and much detached evidence, that many of the pairs of saints in the Christian calendar could be traced back to a connexion with a cult of the Great Twin Brethren. Further studies on analogous lines, issued separately, dealt with the cults of Dionysos, Apollo, Artemis and Aphrodite; two major works were "The Ascent of Olympus" and "Picus who is also Zeus".

Prof. Richard Bär

SWISS physics and Swiss physicists suffered a severe loss, when, on December 13, 1940, Prof. Richard Bär died in his home in Zurich (where he had been professor of physics in the University)—a home whose hospitality many of his colleagues from all parts of the world will remember, having passed the friendly town on pleasure trips to the Alps and having met there not only with the friendliest reception but with one of the most distinguished of Switzerland's learned and literary circles.

Only now, after his premature death, it has been known how lavishly R. Bär had used his wealth to alleviate the lot of the distressed—in the first place of those uprooted by any kind of spiritual intolerance. He had a sort of shyness of giving and would, ostensibly, deny his assistance but send the applicants to a friend of his, pretending that his friend was in charge of an ample assistance fund (which he actually was, but the fund was supplied by R. Bär). I am told that the reception of about thirty displaced scholars at Istanbul was mainly due to R. Bär's initiative, who seized the prospect as soon as it turned up and arranged matters by a personal visit to Istanbul, to which he invited two influential friends.

To most physicists R. Bär is best known by his vigorous and fully successful attempt to disprove by clear and decisive experiments the doubts which F. Ehrenhaft (Vienna) had thrown on the reality of the "elementary quantum of electricity". The doubts were serious, and a detailed experimental refutation was needed to support our theoretical convictions. His later work included important discoveries in the domain of electrical discharge through gases, of the Raman effect and of ultra-sonic waves. It was right in the middle of very beautiful results on the latter phenomenon—diffraction of light by a liquid that is permeated by ultra-sonic waves and thereby turned into a diffraction grating—that his untimely death has occurred. To all this work of his a singular fact, which seldom occurs, gave a peculiarly inspiring tinge: he had begun as a pure mathematician (he had been David Hilbert's assistant during 1916–17) and ended up as an experimental physicist.

ERWIN SCHRÖDINGER.

WE regret to announce the following deaths:

Prof. C. G. Cullis, professor of mining geology in the Royal School of Mines (Imperial College of Science and Technology), on April 27.

Mr. Francis Druce, the well-known botanist, hon. treasurer of the Royal Meteorological Socity during 1913–18 and 1925–32, and of the Linnean Society during 1931–40, by enemy action.

Prof. F. Francis, emeritus professor of chemistry in the University of Bristol, on April 15.

Mr. Hans G. P. Meier, librarian of the Warburg Institute, by enemy action.

Miss J. A. Paterson, librarian of Bedford College for Women (University of London), by enemy action.

NEWS AND VIEWS

The Democracies and Honour

By means of the radio, Mr. Winston Churchill and General Smuts, who will surely go down in history as two of the leading statesmen of these days, recently gave addresses which will mark, possibly the close of a stage, possibly the opening of a new period of activity, in the progress of the War. Mr. Churchill gave a careful and moderately worded survey of the present position in the Balkans, North Africa and the Atlantic. He did not minimize the difficulties of the situation, but he made it quite clear that we could not have done otherwise than we did in answering the call of Greece; to have left Greece to her fate "would be fatal to the honour of the British Empire, without which we could neither hope nor deserve to win this hard war". It is by actions such as this, and by our bearing under the pitiless rain of blows aimed at our cities and our merchant ships as well as at our armed forces, that we have gained the admiration and support of the people of the United States, and in spite of all the arguments about American interests and safety being threatened by Nazi doctrines, "the action of the United States will be dictated not by methodical calculations of profit and loss, but by moral sentiments and that gleaming flash of resolve which lifts the hearts of men and nations, and springs from the spiritual foundations of human life itself".

By the honourable discharge of our obligations to the utmost of our available power, we have encouraged the peoples of the Balkans, and others as well, to believe in the good faith of the democracies. Whereas the Germans, Mr. Churchill said, have made "a river of blood and hate between themselves and the Greek and Yugoslav peoples", the British Empire has won admiration and sympathy. As General Smuts put it: "Great Britain has been investing in friendships, as Germany has been investing in hatreds in the process of war, and Great Britain has thus been building up the moral capital with which the real new order will be floated after the peace". Both speakers urged the need for a just appreciation of the significance of events in the Mediterranean area, but stressed that the vital theatre of war is in the West, in Britain and on the Atlantic, where the recent extension of the American neutrality patrol has given us most valuable assistance.

Aircraft Production

Speaking in the House of Lords, in reply to a request from Lord Sempill, Lord Beaverbrook recently disclosed several facts of technical interest with regard to R.A.F. equipment. One significant statement was that the Napier 'Sabre' engine has proved successful and is in production, both in Great Britain and the United States. This engine was put into production without going through the usual period of testing—a procedure contrary to all normal peace-time practice. It was designed by Major Halford, and develops a horse-power of 2,400. It is at present being fitted to the Hawker-Siddeley 'Typhoon', a new fighter capable of a speed of more than four hundred miles an hour, with a greater range than any previous single-seater type. Aircraft from the United States, including the new 'Catalina B.P.Y.' flying boat, the Curtiss 'Tomahawk', the Boeing 'Flying Fortress' and entirely Canadian built 'Hurricane' are now being received in quantities, nearly a thousand to date, and the air ferry system, by which many are delivered by air across the Atlantic, will soon be extended so that fighters as well as bombers may be sent in this way. Such journeys have been made in 7½ hours, coast to coast, compared with 20 hours, the schedule time for the American Clipper to Lisbon. The fact wat disclosed that the only aircraft that has been loss during this service was unfortunately one that was carrying Sir Frederick Banting as a passenger (see p. 535 of this issue).

The development of a new high explosive bomb is proceeding successfully, and recently Squadron Leader Garner, one of the officers responsible for the technical side of this work, flew over the town of Emden with the "greatest bomb that has ever been dropped from an aeroplane", observing the effects for himself. The supply of raw materials, and equipment such as guns, navigation instruments, radio apparatus, etc., has given anxiety, but is improving. Most aircraft and aero-engine manufacturers have agreed that their demands for materials are now being satisfied, but it is admitted that a certain equipment shortage still exists. The dispersal of production centres, as an antidote to enemy bombing, is claimed to be a success. One plant, until recently on a single site, is now dispersed to forty-two centres in five different counties, and at the same time duplicate production of each item has been arranged so that the loss of any one plant cannot entirely hold up production of a unit.

Scientific Liaison with America

In a written reply to a Parliamentary question on April 29, Mr. Butler, Under-Secretary for Foreign Affairs, said: "After consultation with the appropriate authorities in the United States, His Majesty's Government have drawn up a comprehensive scheme, which has already been put into operation, for co-operation in scientific matters with the United

States of America. His Majesty's Government have selected and sent Dr. Darwin, the director of the National Physical Laboratory, as director of a Central Scientific Office, working under the direction of the British Supply Council in North America. Dr. Darwin's duty will be to collaborate with United States research bodies, to act as a channel for the exchange with the appropriate United States authorities of technical and scientific information, and generally to co-ordinate scientific and technical inquiries to and from the United States authorities, except in those matters which are already dealt with through the Service attachés. In addition, Dr. Conant, the president of Harvard University, recently visited England as President Roosevelt's representative in order to establish a corresponding mission in this country."

Advisory Committee on Engineering in Warfare

THE Lord President of the Council, with the approval of the Prime Minister, has appointed an Engineering Advisory Committee under the chairmanship of Lord Hankey to advise the Government upon engineering questions connected with the war effort and in particular: "To consider how the resources of the engineering profession can best be utilized in connexion with the war work of Government departments, and to nominate engineers who might suitably be invited to undertake particular tasks. To suggest means of improving or supplementing the methods adopted by Government departments for utilizing engineering science for war purposes. To advise on problems referred to them in connexion with the development of new engineering devices, and to advise on methods of bringing such devices speedily into production, and on means of meeting new war requirements in the engineering field. To examine new ideas or devices in engineering likely to assist the war effort, to test their technical validity, and to bring to the notice of the Government those which appear to merit further consideration by the department concerned."

The Committee will consist of Lord Hankey, Chancellor of the Duchy of Lancaster (*chairman*); Lord Falmouth (*vice-chairman*); Sir Henry Tizard, rector of the Imperial College of Science and Technology. The rest have been selected after consultation with the presidents of the Institutions of Civil Mechanical and Electrical Engineers and are as follows: Mr. J. R. Beard, of Merz and McLellan, consulting engineers; Dr. A. P. M. Fleming, director of the Research and Education Departments, Metropolitan-Vickers Electrical Co. Ltd.; Mr. W. T. Halcrow, consulting engineer; Prof. B. W. Holman, assistant professor and University reader in mining in the Imperial College of Science and Technology, London; Dr. C. C. Paterson, director of the Research Laboratories, General Electric Co. Ltd.; Mr. H. R. Ricardo, technical director of Ricardo and Co. Ltd., consulting engineers; Dr. A. Robertson, principal of the Merchant Venturers' Technical College, Bristol.

Post-War Problems for Chemical Industries

THERE has been an increasing tendency of late for presidential addresses to deal with topics that lie outside the scope of the scientific or technical society concerned. We have had physicists dilating upon metaphysics, chemists on agriculture, biologists on politics, and nearly all on education or economics. This practice is not to be summarily condemned, because it indicates that at least some scientific men are abandoning their old attitude of 'splendid isolation' from human affairs, though at times one is reminded of Bernard Shaw's dictum that no one ever learned to do one thing by doing something else. Mr. F. Heron Rogers, in his address to the nineteenth annual meeting of the Institution of Chemical Engineers, held on April 4 in London, proved no exception to this tendency. In his view, war is inevitable, and the 'fittest' who survive in life's struggles are those who are "strong in arms and in honour".

Probably the most serious after-war problem, says Mr. Rogers, will be that of finance, conjoined with the maintenance of our industries and finding work for all. In planning post-war industries, regard must be had for safety of buildings, etc., and this will be best attained by dispersion and by troglodytic working in caves. Great Britain must be made less dependent upon other countries for its necessities, such as mineral oils, timber and food. A calcium carbide industry is essential for producing acetylene and the numerous useful substances derivable from it, while further research on coal-tar products is needed to increase the number of useful aromatic compounds, like solvents, dyes and intermediates. Basic to our industrial life is research on the problem of eliminating sulphur, phosphorus and arsenic from carbonaceous materials, the solution of which would give an enormous impetus to the iron and steel industries and ease all our metallurgical operations. Research is also needed on the utilization of waste materials, which includes problems of extraction, dehydration, disintegration, pressure-filtering, and similar engineering processes. Given a period free of unwise governmental and political interference, and freedom from subsidized competition, great strides in which chemical engineering would play its part could be made towards post-war safety and happiness.

Psychological Terms used in Head Injuries

THE Brain Injuries Committee of the Medical Research Council, in War Memorandum No. 4 (London: H.M. Stationery Office. 1*d*. net), has compiled a short glossary of psychological terms commonly used in cases of head injuries. The object of the glossary is to secure a greater measure of uniformity in the terminology used in case-notes of patients with head injuries. There is always some difficulty in defining within fixed limits psychological terms, a difficulty that is increased by the fact that many of the terms are also used in popular speech with somewhat vague reference, for example, confusion, hysteria. When a patient suffering from a psychological

derangement resulting from, or coincident with, head injury is referred by a physician to a special centre, it would be advantageous if the same meaning were attached to the same words. To further this aim sixteen words in common use have been defined. It is possible that another committee might have arrived at a slightly different phraseology, but although general acceptance cannot be expected, yet here is a very useful beginning, and the glossary will probably have a gradually widening sphere of application. Some of the terms defined are: *coma*, *confusion*, *delirium*, *traumatic stupor*, *concussion*, *malingering*, *hysteria*.

An Early Marine Engineering Institution

In *Engineering* of April 4, Eng.-Captain E. C. Smith gives a short history of the almost forgotten Institution of Marine Engineers, which existed from 1876 until 1879. It came to a close ten years before the present Institute of Marine Engineers was founded, and it does not appear there was any connexion between the two. The Institution grew out of a Registry of Sea-Going Engineers, afterwards called the Associated Marine Engineers, founded in the City of London. In January 1876, the *Marine Engineering News*, the forerunner of the present *Marine Engineer*, was founded, and the editor of this and the secretary of the Institution were one and the same person, Matthew Augustus Soul, a patent agent. Another leading figure in the activities of both journal and society was Nicholas Proctor Burgh, the writer of several books on engines and steam, on the latter of which he held some unusual views. The other promoters of the Institution were consulting engineers in the City of London. The aims of the Institution were admirable. Papers were to be read, a museum and library formed, and a provident fund started; but evidently affairs did not flourish, for both Institution and *News* came to a close in 1879, leaving little trace of their doings.

Meteorology in India

No drastic changes are indicated in the Report on the Administration of the Meteorological Department of India in 1939–40 (Pp. iii + 35 + 8 plates. Delhi: Manager of Publications, 1940. 1.2 rupees; 3*s*. 9*d*.). A start has been made on the construction of new buildings at New Delhi for the Upper Air Office, which is to be transferred to that city from Agra. Thirty acres of land have been acquired for this purpose, and the buildings were begun in December 1939; they were expected to be ready for occupation towards the end of 1940. The forecasting office at New Delhi, which was closed as a measure of economy in 1932, at a time of financial stringency, was re-opened, and at about the same time a new wireless station attached to the Poona Meteorological Office began to function. These last two developments allowed the Department to complete its "regional synoptic" scheme for the broadcasting of station weather reports. The stations included in these broadcasts, and in similar broadcasts from Karachi, Calcutta and Rangoon, are shown in plate I of the report, and those included in the "Collective Synoptics" in the same plate.

In addition to carrying on the ordinary routine work, so far as war-time restrictions permitted, special investigations were made, among which was one into the seismological features of the Satpura Range earthquake of March 14, 1938. Daily measurements of ozone in the upper atmosphere were begun at the headquarters' office towards the end of 1939 with the aid of a Dobson photo-electric spectrophotometer. Assistance was given to a scientific expedition from the United States under the leadership of Dr. R. A. Millikan, of the California Institute of Technology, Pasadena, mainly by the staff of Agra Observatory. This expedition made observations of cosmic rays at Agra, Gwalior, Peshawar and Bangalore, using large balloons to which were attached recording electroscopes and ion counters fitted with *radio sondes*.

New Instruments in Physics

An interesting account of the debt of modern physics to recent instruments comes from the Bell Telephone Laboratories in New York and is given by Karl K. Darrow (*Review of Scientific Instruments*, 12, 1–10; Jan.; 53–61, Feb. 1941). The instruments are classified into three types according as they are devoted primarily to observation, to measurement or to achieving new conditions. In the first article consideration is given to those instruments in which substances can be subjected to new combinations of physical forces or in which one variable is pushed to extreme limits. Bridgman's scheme for achieving pressures of the order of 100,000 atmospheres, Beams's ultracentrifuge rotating at more than 20,000 turns per second, the piezo-electric or magnetostriction oscillator, the Dickel and Clusius use of convection and thermal diffusion to separate isotopes, the attainment of vacua of the order of 10^{-8} or 10^{-9} mm. mercury, by the aid of oil diffusion pumps and 'getters', the attainment of temperatures of only a few hundredths of a degree absolute, and of high electric voltages, and magnetic field strengths are all dealt with. The second article is devoted to instruments of observation and instruments of measurement without enforcing too sharp a distinction to the two types. Both articles are well illustrated and give an excellent idea of the present limits reached in most branches of modern physics. The developments in that protean tool, the thermionic vacuum valve, and its resulting developments in acoustics are so great that another article would have been necessary to deal with them.

The Smithsonian Institution: Annual Report.

The report of the Smithsonian Institution for the year ending June 30, 1940, includes the report of the secretary, the financial report of the executive committee of the Board of Regents, together with reports on the United States National Museum, the National Gallery of Art, the National Collection of Fine Arts, the Freer Gallery of Art, the Bureau of American Entomology, the International Exchange Service, the

National Zoological Park, the Astrophysical Observatory and the Division of Radiation and Organisms. The last-named refers to further work on the problems of photosynthesis and factors affecting plant growth both from a nutritional and radiation point of view. Many measurements have been made of the rate of carbon dioxide uptake and the intensity of fluorescence during the induction period of photosynthesis, and respiration and chlorophyll studies have been continued with a recording spectrographic carbon dioxide apparatus. A standardized technique has been worked out for the extraction of plant growth substances from the oat seedling. Publication of the final revised values of all solar constant results from all observing stations from 1923 to the present time is expected during the coming year. Archæological excavations in south-east Mexico have been continued in co-operation with the National Geographic Society. Excavations at the Lindenmeier site in northern Colorado have afforded much additional evidence of the presence of Folsom man.

Publications handled by the International Exchange Service, which serves as the official agency in the United States for exchange with foreign countries of documents and scientific publications, considerably decreased during the year, as the exchange of publications was suspended between the United States and all European countries except Great Britain, Finland and the Soviet Republic. A list of foreign depositories of Government documents is included in the report. The work of the Astrophysical Observatory concerning the radiation of the sun has been continued, and Dr. C. G. Abbot has endeavoured to evaluate the separate influences produced on weather by long-range solar periodicities, and changes in phase of the weather responses have been found to be due to seasonal influences.

Recent Earthquakes recorded at Kew

DURING the week April 13–20, six large earthquakes were recorded at Kew Observatory. Three were on April 15, and there was one each on April 18, 19 and 20. The first on April 15 was very distant and the second was the important earthquake with epicentre near Colima (Mexico) (NATURE, April 26, p. 507). This began recording with *iP* compressional on all three components at 19h. 22m. 19s. G.M.T. on April 15, and there followed a full suite of pulses, including *iS* on all three components at 19h. 32m. 39s. G.M.T., eL_Q on *N* and *E* at 19h. 46m. G.M.T., and eL_R on the vertical and *E* components at 19h. 50m. G.M.T. The earthquake finished recording at midnight on April 15, but what was probably the *iP* wave of an aftershock recorded on the vertical component seismograph at 19h. 58m. 25s. G.M.T. on April 15, superposed on the first. The maximum of the chief earthquake attained a ground amplitude of 880 μ at Kew. The shock on April 18 only gave rise to small amplitudes. The one on April 19 recorded *iP* dilatational on the *Z* component at 8h. 4m. 23s. G.M.T. and probably had its epicentre 7,220 km. away. The earthquake on April 20 attained an amplitude of 69 μ at Kew and was the second largest in the week. It began recording at 17h. 47m. 17s. G.M.T. with *iP* on the *Z* component probably from an epicentral distance of 5,440 km., and finished recording at 18h. 40m.

Earthquakes recorded in Switzerland

THE Swiss Earthquake Bulletins from Zurich for November and December 1940 have just been received. Eight large earthquakes were recorded in November, and 10 in December. The earthquake of November 7, 1940 ,was recorded at all four observatories of Zurich, Chur, Basel and Neuchâtel and was felt with intensity IV at Gemeinde Muotatal, and at Schwyz with intensity III–IV. The earthquake of November 10 may have had its epicentre near Bucharest, and several aftershocks were also recorded. The shock of November 19 may have been near the Pacific Coast of northern Japan. On December 12 an earthquake, recorded at Chur, Zurich and Basel was felt with intensity IV in the region of the Mürtschenstock, Kt. Glarus, whilst the shock well recorded on December 22 at all four observatories, and in particular at Neuchâtel at 19h. 12m. 36·9s. G.M.T., probably had its epicentre in Central America.

Announcements

THE title of reader in histology in the University of London has been conferred on Mr. Keith C. Richardson in respect of the post held by him at University College.

THE Institute of Wireless Technology and the British Institution of Radio Engineers have fused, and in future the combined body will be known as "The British Institution of Radio Engineers Incorporated with the Institute of Wireless Technology". The president is Mr. S. A. Hurren, and Mr. G. D. Clifford has been appointed general secretary. The first annual general meeting of the combined body will be held in June, when the election of a council for 1941–42 will take place. All communications should be addressed to the Institution at Duke Street House, Duke Street, London, W.1.

A RECENT issue of the *Evening Standard* (London) quotes a British United Press message stating that traces of "a hitherto unknown prehistoric civilization have been found at Ipiutak on Point Hope, Alaska". It was already known that a very early and well-developed culture existed in Alaska, and the above message suggests new finds, confirmation of which will be awaited with interest.

THERE seems to be some misunderstanding concerning the leading article entitled "Relationship of Pure and Applied Biology" which was published in NATURE of April 12, p. 427. As a leading article, the views expressed are, of course, those of the editors of NATURE (formulated after considerable inquiry), and not those of a single individual. Neither is the article a summary of the discussion (to which reference is made) at a joint meeting of the Association of Applied Biologists and the Society for Experimental Biology. Summaries of discussions are published as such, and not as leading articles.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

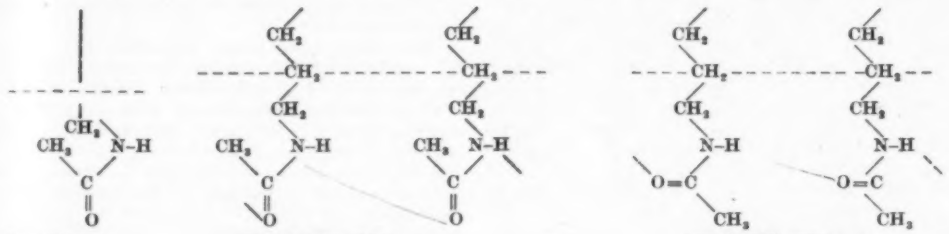
A Possible New Approach to the Study of the Hydrogen Bond in Protein Structure

In a recent review[1] Astbury has pointed out that the role of the hydrogen bond in protein structure, usually ascribed primarily to the keto-imino group, is largely unknown. Determination of the structure of such polar groups in the aqueous medium necessary for the normal functioning of the protein molecule is not easily achieved by means of the usual X-ray and infra-red methods. The monolayer technique has, however, proved of value in certain cases[2], and recent measurements upon simple compounds containing the –CO.NH– link indicate that cross hydrogen bonding between such groups does occur in water provided that the molecular spacing is suitable.

The above principles are shown up most clearly by the acetamides which have now been studied in detail by both force-area and surface potential methods. The figure below shows the head-group configuration deduced for the expanded state and for the high- and low-temperature condensed forms.

Chain-length $C_{15}H_{33}$ in all cases.						
Head-group	–O.CO.CH$_3$	–COCH$_3$	–COOCH$_3$	–COOH	–CHNOH	–CONH$_2$	–NHCONH
$T_{1/2}$	20°	33°	34°	37·5°	42°	44°	48°
Nature of condensed film	Liq.	Liq.	Liq.	'Plastic solid'	Not known	Solid	Solid

In the acetates configurations almost identical with the first two are known[3], but there is nothing at all analogous to the third, where stabilization is obtained by cross hydrogen bonding. In addition to the hydrogen bond distances it is also possible to calculate, approximately, the free energy difference between the –CO.NH– group when forming hydrogen bonds with water (as in the expanded films), and when



EXPANDED FORM
$A > 47$ A.^{2}
μ = 302 milli-Debyes
No cross hydrogen bonding.
Liquid film.

HIGH T. COND. FORM
A *c.* 24 A.^{2} (tilted chains)
μ *c.* 350 *m–D.*
Weak hydrogen bonding (bond distance *c.* 4 A.).
Liquid film.

LOW T. COND. FORM
A = 21 A.^{2} (vertical chains).
μ *c.* 390 *m–D.*
Strong hydrogen bonding (bond distance *c.* 2·8 A.).
Rigid solid film.

(Water surface undefined but parallel to the horizontal dotted line.)

Condensed monolayers of acetamides and ureas were shown by Adam[3] to exist in two forms with a definite transition temperature, the latter being unusual in giving solid films even at an area of 26 A.^{2}. (Solid monolayers are usually only obtained with close-packed, vertical chains at 20–21 A.^{2}.) These and other facts are readily explicable by assuming cross hydrogen bonding between the molecules in the monolayer. A comparison between substituted amides and the corresponding esters which cannot form cross hydrogen bonds, for example, octadecyl acetamide and acetate, methyl stearamide and stearate, shows that the former tend to give very stable solid, and the latter much less stable fluid, films. The half-expansion temperatures ($T_{1/2}$) given by Adam[4] are also much higher for the compounds for which cross hydrogen bonding in the monolayer is now postulated (amides, ureas, aldoximes and acids), and the tendency towards solidification is also very apparent (see accompanying table).

Calculation of the hydrogen bond distances in the various cases gives results in quite good agreement with known values; for example, acetamides 2·8 A. at 21 A.^{2}, ureas 3·2 A. at 26 A.^{2}, acids 2·8 A. at 24 A.^{2}. cross-linked (as in the low-temperature condensed form). The latter is found to be the more stable by about 800 cal./gm. mol.

The stabilizing action of the cross hydrogen bonds can be decreased, leading to liquefaction, by strongly acid substrates (for example, $5N.H_2SO_4$), as well as by increase of temperature. The effect of other reagents, such as urea, is being examined.

Similar considerations can be advanced to interpret the monolayer behaviour of the ureas, other amides, aldoximes, unsubstituted and α-amino acids, as well as mixed films, and will be given with further details in a forthcoming publication.

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April 5.

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[2] Alexander, *J. Chem. Soc.*, 177 (1939).
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Organic Bond Strengths and the Heat of Vaporization of Carbon

KINETIC studies on several independent chemical reactions have led to a value of about 104 kcal. for the heat X of removal of the first hydrogen from methane. Thus Trenner, Morikawa and H. S. Taylor[1] obtained 108 ± 5 kcal. from the reaction of deuterium atoms with methane, Patat[2] a value of about 103 kcal. from the *ortho-para* hydrogen conversion by methyl radicals, and Rice and Dooley[3] a value 100 ± 6 kcal. from the thermal decomposition of methane at high temperatures. Butler and Polanyi[4] have measured the velocity of the homogeneous thermal decomposition of alkyl iodides at low pressures, and their results, together with some thermo-chemical data, lead to the value $X = 103{\cdot}6$[5].

From this value and the known heats of reaction, $2CH_4 \rightarrow C_2H_6 + H_2$ and $H_2 \rightarrow 2H$, the C–C bond strength in ethane is 88·2[5]. (Rice and Johnstone[6] from the concentration, at various temperatures, of free radicals in ethane obtained a value of about 80 kcal.)

In his recent book "The Nature of the Chemical Bond"[7] Pauling has recommended an average bond strength for C–C of 58·6 kcal. It is the object of this letter to point out this serious discrepancy and to suggest an explanation; the variations in bond energies established by Rossini[8] are too small to account for it. Since Pauling's C–H bond strength (87·3) "is the value given by methane", that is, the average of the heats of the four successive hydrogenations of a carbon atom, a possible explanation is that the *first* C–H bond broken in methane is considerably stronger than the others. This would lead to too low a value for the C–C in ethane. Taking this first bond strength as 104 and assuming Pauling's average value, the average of the other three C–H bonds would be only 82 kcal. Two arguments oppose this interpretation: (1) Voge[9] has calculated the energies of these successive reactions approximately by quantum mechanics and obtained no such large differences. (2) The heat of successive substitution of the hydrogens in methane by a halogen varies but little along the series given by each halogen. Thus from the data for the heats of formation of the appropriate compounds given by Bichowsky and Rossini[10], these substitution heats are (for the processes CH_4 + Hal. → CH_3Hal. + H, CH_2Hal. + Hal. → CH_2Hal.$_2$ + H, . . . etc.): for substitution by Cl, − 21·1, − 21·4, − 21·1, − 20·7, by Br, − 35·0, − 32·5, − 32·0, − 31·0, by I, − 49·0, − 46·8, − 45·3 (fourth step unknown). It is difficult to see how such constancy for all three halogens is compatible with a large variation in the C–H bond strengths.

If, therefore, this hypothesis is excluded, Pauling's table of carbon bond strengths must embody some systematic error. The obvious possibility is uncertainty in the heat of formation V of carbon, as monatomic vapour, from carbon in the standard state (graphite or diamond). Two methods exist for the determination of V: (*a*) the spectroscopically observed dissociation energy of carbon monoxide can be related to it by known combustion heats; (*b*) by observation of the vapour pressure of graphite. Goldfinger and Jeunehomme[11] have considered that method (*a*) leaves three values possible: − 168·8, − 123·6, and − 107 kcal. They calculated the vapour pressures corresponding to each and compared these calculations with experiment. Their results show that the lowest value is very improbable, but, although the most modern and accurate determinations agree best with the highest of these three values, they adopt $V = -123{\cdot}6$, the value recommended from considerations of spectra by Herzberg[12]. As Herzberg pointed out, the vibrational levels are insufficiently known for a Birge-Sponer extrapolation, so that the evidence for V depends on the interpretation of certain predissociation limits and the assumption that these are not 'accidental'; moreover, Schmid and Gerö[13] have considered these data as supporting a value of V of only 73 kcal., which is on chemical grounds very unlikely. The spectroscopic results are not, therefore, unequivocal, while the high value 168·8 is supported by some calculations (of which the details were not given) by Penney[14], who obtained $V = 170$, "a value unlikely to be in error by more than 10%".

Now it can be shown that in these average bond strength systems, if V is too low by x, the C–H value will be too low by $\frac{1}{4}x$, the C–C by $\frac{1}{2}x$, and the C=C by x. If we take the high value 168·8 for V, Pauling's C–H of 87·3 becomes 98·6, his C–C of 58·6 becomes 81·2, and his C=C of 100 becomes 145. A similar correction to the 'average' bond strengths of Sidgwick[15], who took $V = 150$, gives for the aliphatic series C–H 98·4, C–C 81·1, C=C 143. These corrected values agree, to within the uncertainty inherent in 'average' bond strengths, with those derived from consideration of the decomposition kinetics of alkyl iodides[4,5].

The single assumption, therefore, that the heat of vaporization of graphite to monatomic carbon vapour is 168·8 or thereabouts is sufficient to reconcile the serious discrepancies between 'kinetic' and 'thermochemical' values for carbon bond strengths. In view of this fact, it would be of interest if further spectroscopic research could give a definitive answer to this question of the heat of dissociation of carbon monoxide.

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March 28

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Use of Silver Nitrate for the Histochemical Demonstration of Ascorbic Acid

SILVER nitrate in acid solution has been widely used for the study of the distribution of ascorbic acid in tissues and cells[1]. A survey has recently been made, using this method, of its occurrence in chick embryos[2]. During this study a previously unreported phenomenon was observed in newly calcified bone: this was a heavy dark deposit which filled many of the newly formed trabeculæ of cartilage and mem-

brane bone. The histological picture was similar to that produced in developiug bones by the use of von Kossa's silver nitrate technique for the demonstration of calcium. A related phenomenon has been observed in the long bones of adult rats, which become bright yellow on treatment with acid silver nitrate. In specimens from both these types of bone prepared for histological examination there are seen dark deposits in many of the trabeculæ, quite different in character from the small black granules seen in other tissues treated by this method.

In view of the possibility that the atypical deposits seen might have been produced by the precipitation of a silver salt, followed by photo-decomposition of the salt during the preparation of sections, the following experiment was made. The femurs and frontal bones from twelve chick embryos of various ages were used. One frontal bone and one femur from each embryo was treated in the normal fashion and one frontal bone and one femur was placed in 5 per cent ammonia for 10–15 minutes after fixation in acid silver nitrate and washing in water. Fixation, washing and treatment with ammonia were carried out in brown bottles in each instance. In all instances in which acid silver nitrate produced discoloration of the bone, subsequent treatment with ammonia restored the normal appearance, and atypical deposits were absent in histological preparations. Similar results were obtained with rat bone. Treatment of rat adrenals with ammonia after fixation in acid silver nitrate had no effect on the histological picture.

These results indicate that in some tissues the histological picture produced by the reduction of silver nitrate in acid solution by ascorbic acid may be complicated by a process which is probably due to the precipitation of silver salts followed by photo-decomposition; this complication can be obviated by treatment of the specimen with 5 per cent ammonia. It is suggested that this treatment with ammonia after fixation in acid silver nitrate constitutes an improvement in the technique for the histochemical demonstration of ascorbic acid, in that it increases its specificity.

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[1] Bourne, G., NATURE, 131, 874 (1933); *Austr. J. Exp. Biol. Med.*, 11, 261 (1933); *Anat. Rec.*, 66, 369 (1936); Giroud, A., and Leblond, C. P., NATURE, 138, 247 (1936); Giroud, A., "L'acide ascorbique dans la Cellule et les Tissues" (Paris, 1938).
[2] Barnett, S. A., and Bourne, G., *J. Anat.*, 75, 251 (1941); *Quart J. Micr. Sci.* (in the press).

Dependence of the Direction of Rectification in Copper Pyrites on Voltage, Temperature and Time of Measurement

The reversal of rectification by heat in molybdenite[1] led to the study of the rectifying properties of copper – copper pyrites contacts. In most cases, it has been found that below 1 steady volt the normal direction of easy flow is from the metal, but it reversed between 20° and 200° C. For voltages of the order of several volts, the conductive direction is from the crystal, but it reversed between 20° and − 78° C. The relation between the transition voltage and the transition temperature indicates that above a critical temperature of about 500° K., or above a critical P.D. in the neighbourhood of 20 volts extrapolated at the absolute zero, the direction of rectification is always the same. A similar phenomenon occurs in thermocouples when the cold junction is above the neutral point, or when the temperature difference between the two junctions exceeds twice the neutral temperature.

On changing from D.C. to A.C., it is occasionally observed that the direction of the rectified current is opposite to the direction of the larger current. This is explained by a time lag in the current, arising from the contribution of some integrative action related to the direction of the applied voltage.

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[1] El-Sherbini and Yousef, *Proc. Phys. Soc.*, 51, 449 (1939).

Sense of Hearing in Fishes

In his review of our knowledge of the sense of hearing in fishes, von Frisch[1] only quotes one observation in the field, and in his summary says, "spontaneous reactions to musical tones are not to be expected, since the sound signals used by us have no biological significance for fishes. Reliable reactions can therefore only be obtained by conditioning to tones."

It may therefore be of interest to put on record an observation that I made some years ago in British Guiana on the response of fishes to sound under natural conditions. I was at the time visiting at frequent intervals Plantation Ogle, a sugar estate in the low-lying coastal area south-east of Georgetown. The estates are drained by a number of shallow canals along which the sugar-cane is towed in barges to the factories, and there are many low hump-backed bridges over these canals.

I find in my note-book the following, dated September 16, 1916. "In crossing a bridge over one of the trenches I noticed that numerous small fish were surface feeding in small groups in the water, but at an accidental noise they all dived deep. I tried waving my arms suddenly without noise but this had no effect. Clapping my hands or ringing my bicycle bell, on the other hand, caused them to dive so suddenly that the whole surface of the water was disturbed." I repeated the observations on several days and distinctly remember one experiment in which I laid my cycle on the ground and crouched low so that I could only just see the surface of the water. When I rang the bicycle bell, the only movement being that of my thumb which was in any event quite out of sight of the fishes, the response was immediate and striking.

There is no doubt in my mind that these fishes heard and reacted to a sound which, according to von Frisch, should have "no biological significance" to them; but what natural warning sound, if any, it simulated I am unable to suggest.

Perhaps some resident of British Guiana could repeat my experiment and get some of the fish identified.

I may add that I have recently tried the effect of a bicycle bell on goldfish in a pond here at Rothamsted but cannot see that the fish respond in any way.

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[1] *Biol. Rev.*, 11, 210 (1936); see also NATURE, 141, 8 (1938).

The Cleavage in Biology

THE leading article on the "Relationship of Pure and Applied Biology" (NATURE, **147**, 427; 1941) paints a lamentable picture of the separation of pure and applied biology, lamentable because, as it claims, each is needed to fertilize the other. The article explains how in the universities research has become an end in itself and purity its ideal. It implies also that in research stations utility often provides an opposite and exclusive ideal. Each of the two ideals justifies its own kind of enthusiasm for research and persuades us of the reality of the opposition between them. Nothing but good can come of showing that the opposition is unnecessary; that snobbery and counter-snobbery are equally artificial, and that pure research can develop as it should develop only if it is continually harassed by the demands of necessity. It is the absence of necessity or apparent use that in past times has often led science, or some parts of it, into backwaters where the inevitable weeds of scholasticism have clogged its stagnant channels.

All this is clear enough; but it is not the root of the matter. There is, as the article says, underlying the cleavage of ideals a cleavage of organization and material resources. With a few important exceptions there is a division in biological research between those who have to teach in the universities and are free to follow pure research in their spare time, and those again who work in research institutes of medicine or agriculture and who to a greater or less extent are expected to achieve practical results. Each party develops its own comfortable philosophy, comfortable at least in a stable environment. *Il n'est point de sot métier.*

The separation of teaching from applied research does harm to the research. New recruits to research from the universities have to unlearn a great deal of what they have learnt and, having in this way lost their simple faith, stand a poor chance of being allowed to teach again. But consider the harm it does to the teaching. A professor of botany told me recently that it was no use trying to develop the teaching of botany into something more useful since botany was only taught to people who would teach botany to people—and so on for ever. This is the principle of the 'fundamental training' seen from the other side of the hedge. Is it any wonder that the standard university text-books scarcely mention any of the uses that can be made of a knowledge of plants and animals? And that they confine their statements about genetics and cytology, for example, to a reiteration of formulæ which have obviously meant as little to the men who write them as they will to the men who read them?

Surely then the remedy is not, as the article proposes, an interchange of personnel between institutions which continue to pursue divergent paths of pure and applied research. Such a policy would touch only the surface. No, the union of interests must be complete. The divergence must be suppressed; and it must be suppressed by the fusion of pure and applied research, by the fusion of both with teaching.

A radical reconstruction is therefore needed in the relations of teaching and research, of universities and stations. Let no one object that fearful obstacles lie in the way. Of course they do. Thirty years will be needed to accomplish the change. But accomplished it will be.

Once an organic union of the two parties is established the rest will follow. Syllabuses will be revised, the necessary 'fundamental training' will become much more fundamental and much more of a training. The sterile separation of botany and zoology will become a fruitful union. The combination of small departments will bring them to a size suitable to the work in hand. The importance of chemistry and statistics and even downright craftsmanship will be admitted and exploited; and, by accident or design, the impossible hope of NATURE will have been realized—a training in biology will have become an education in itself.

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London, S.W.19.
April 18.

As Dr. Darlington points out, the divergence between pure and applied biology must be suppressed "by the fusion of pure and applied research, by the fusion of both with teaching". Thirty years, indeed, will be needed for this, if not much longer. To effect this remedy immediately is, of course, impossible; then surely the suggested interchange of personnel should be the immediate aim with complete fusion as the ultimate aim.—Editors of "NATURE".

"The Man of Science as Aristocrat"

IT is indeed a privilege that in NATURE we can enjoy an article by Mr. H. G. Wells. I, like him, would like to preface the remarks I have to make upon his contribution by paying my modest tribute to NATURE. I know nothing more wholesome than a perusal of the "Letters", at least 50 per cent of which must be pure gibberish to most people, but absorbing to the few interested in their particular subject raised. Humility of mind over such abysmal ignorance of so many subjects is a fine correction in these days of the 'cock-sure'.

H. G. Wells obviously comes under the head of a man of 'general intelligence'. I make no such claim. I get included by virtue of "a broad curiosity outside the ranks of the specialist worker".

In a debate on Mr. Wells's recent lectures in the United States and why he was allowed to go and air such curious views Mr. Peake, speaking for the Government, put up an admirable defence of his conduct on the ground that we all knew Mr. Wells and that we must look upon him as one of our "invisible exports". I have never quite decided whether Mr. Peake meant very subtly that we can all see through Mr. Wells or not, for although he derides the patent laws and condemns them—"we must all work for the common good"—, I see no urgent advocacy of the abolition of copyright. The miserable capitalist world that recognized Mr. Wells's genius has by its machinery not only kept him from starvation and being 'bumped off', but also made him incidentally one of the most privileged of the privileged classes.

Success in literature has been his, with its reward. If he had levied toll on the world for his invention of the cinematograph, would the "arrogance and detestableness of his nature" have been brought out? Certainly not. It was not brought out by his success in literature for the reason it was not there. A more lovable, maddening man I have never met.

Mr. Wells makes a plea for the man of science to look upon himself as an aristocrat. This, indeed, must make Robespierre turn in his grave, and surely in some States must put some of our friends in danger. To jump from the proletariat, ignoring the *bourgeoisie*, to be an aristocrat, would certainly endanger, I should imagine, Prof. Kapitza's life. Dangerous advice from a socialist; but we get his meaning. I do not think his tongue was in his cheek when he wrote that, but, when Mr. Wells writes, the position of his tongue is important, which goes to show the superiority of the spoken over the written word.

My point is, why should the man of science look upon himself as an aristocrat? Granted, he may be doing work which will be of use to the world and not to himself; a soldier also does that. A man of science works at the subject he adorns because that is his bent in life and where he can best satisfy himself. It does not follow—brutal as it sounds, it must be made clear—that because a man of science is brilliant in his sphere he can take on any job and shine at it. A man can be a brilliant man of science but unable to make his way in life in any other direction. Even Sir Isaac Newton never shone as a member of Parliament. A well-known fellow of the Royal Society complained to me the other day that working as he did in a particular Ministry he was valued for pay on the basis of a major, and I am brutal enough to think that that is about right, once a specialist gets out of his groove.

I agree that the man of science and the specialist working in his groove have produced in our time the motor-car, the aeroplane and the radio, which by the 'wisdom' of man have been turned into the Panzer Division, the night bomber and lying propaganda. All this is indeed desperate, but it does show that technical minds outstrip political wisdom and that it is easier to discover X-rays than to placate Europe.

The sort of article Mr. Wells has given us tends to get all values wrong. Technical research may benefit the world or not, that depends on how it is ultimately used; but for the advancement of the general happiness of mankind concentration by the brains of the country is required on government and planning. That is the most difficult and important of all science. I suppose Mr. Wells would class it as politics and fire squibs at it; but because it is neglected and despised, because there are no chairs and no places for its students in the Royal Society, the most difficult of all subjects is being neglected as science.

Let us get our values right. The man who by his political efforts can get adequate milk to children deserves more of his fellow men than the inventor of the quantum theory; but in the narrow world of science, who gets the most attention and encouragement?

Aristocracy means government by the best. If the man of science means to come out of his shell and help us in the problems and perplexities of life, good luck to him. What we can do without, however, is the specialist, usually with the pen, divorced from all the responsibilities of public life but laying down high priestly criticisms of all and sundry, as if knowledge, foresight and wisdom lay with him alone.

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April 25.

ACCORDING to Mr. H. G. Wells, it would appear that inventors and research workers must be stoically and aristocratically resigned to even worse conditions under democracy than they have hitherto endured under pluto-aristocracy.

But, surely, if democracy abolishes the rich patron, it must be prepared to wear his mantle and do his job.

The precedent is already to hand, for example, in the Civil List, from which State payments—pensions or gratuities—are already made to deserving individuals. It would, of course, be necessary to organize an extensive machinery for administering State patronage—as of right—to all deserving cases; but the advantage to the cause of national progress might be very great. Inventors, research workers, artists and the like would at last be protected from the "Smart Alecs"—they would be rewarded by the State in proportion to the benefits they had rendered to the community.

As to the scale of payments—a progressive manufacturing firm may spend from 1 per cent up to 2 or 3 per cent of its annual turnover on research and development; a wise and progressive democracy might well do the same, and spend as much on research and development as we have hitherto done on national defence.

The same organization might, with great advantage, have the duty of recommending the bestowal of national honours for public services rendered.

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'Pancake' Ice in the Pennines

ON February 2 during a severe frost a visit was made to High Force in Upper Teesdale. The Force was a spectacular and beautiful sight, with a considerable cascade of water descending between great curtains of ice, and heavy icicles draping all the surrounding cliffs formed by the Whin Sill. But it was the pool below the fall itself that invited special attention and comment. Here on the agitated surface were floating rounded pieces of ice, formed apparently at the height of the frost on the pool-surface, which later became disintegrated. Some fragments, however, may have been derived from the surrounding walls, or have descended by the cascade from the upper reaches of the river. Mr. Bentley Beetham, of Barnard Castle, who accompanied me and who has before seen the Force under frozen conditions, favours the first-mentioned alternative for the origin of the ice-glaçons.

It was noticed, moreover—and this is the main point of interest—that the glaçons were not merely rounded, presumably by attrition in the agitated water, but also had their borders sharply raised in the manner of 'pancake' ice of the polar seas. The 'pancakes' were up to about one foot in diameter, and would seem to have been formed under such conditions of temperature and movement—in order to provide the correct plasticity and shape respectively—as are to be found in the well-known examples in the arctic and antarctic seas. The latter have been strikingly illustrated in Wright and Priestley's "Glaciology" of the Scott Antarctic Expedition, 1909.

It is not known that pancake ice has been described from other than polar regions.

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TOWARDS A NEW GEOGRAPHY

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WHATEVER shapely forms the new world of reconstruction will take no one is certain as yet. It will be well if we stand firm in the belief that what we must start from is not some blue print or paper scheme, but from where we are now. The way the nation thinks must be determined, to a large degree, by the way it is taught. An overhaul of our educational system, an examination of the validity of the principles and facts inculcated into the minds of young people, might be a valuable contribution by educationists to the new order democracy hopes to build.

It is with this idea in mind that this article takes up the question of geography as a subject learned and taught. Greek interest in the *oikumene* started off a long lineage of environmental study from Strabo to Bodin, Buckle, Ritter, Herbertson, Geddes and many others. The duality of the environmental concept-man and Nature has been constantly attracting philosophy and science. We are now some distance from Montesquieu, who explained the virtues of the English constitution by the vices of its climate; but determinism will out, and mole hills of causality become mountains of effect. Convention ties the geographers to the bed rock of physical elements, and their human geography is still too much a product of the soil.

In a chapter on the geographical factor in his "National Character", Prof. Ernest Barker, quoting in some degree from the work of Edouard Meyer, has shown some of the fallacies of determinism. It is man, he says, who arouses the dormant energy of natural resources and makes them geographical elements. Coal and iron had been in our soil for millennia before man used them and made them factors in our economic situation. Again, the sea was at our gate for countless ages before we became a maritime nation. Prof. Toynbee in his recent work gives full play to environmental forces in tracing the history of civilizations, and he finds psychological factors as potent as physical, and spiritual vitality as determinant as climate and soil. Febvre again goes so far as to say that it is human activity, not soil and situation, which governs the game. There is no 'law of islands' imposed on human society, only variety and difference. Michelet could say of Flanders, "it has been created so to speak in defiance of Nature. It is a product of human labour". All of which seems to imply that man is a geographical agent, and that if history, as Prof. Rait says, is largely what geography makes it, geography is no less the product of history. The environment of to-day is the sum of all our yesterdays.

It is true that our geographers of to-day allow more room to human initiative and will than of old, but they have a speciality to conserve, and they make strange claims for it. Now it is merely 'a point of view', now 'a synthesis'. As a way of looking at world phenomena the geographical aspect is possibly a necessity in particular cases, but that scarcely makes it a subject. The claim to be a synthetic study results from the method. If you collate data from all and sundry sources you must synthesize or suffer mental indigestion. The trouble is that in fact the geographer has to select what is digestible, but a partial synthesis is not scientific. This may be illustrated by reference to that excellent little classic on "Modern Geography" by the late Dr. Marion Newbigin. It presents a sequence of the varied content of conventional geography. There are the physical aspects of natural landscape, the biogeography of plant and animal life, and the relations of these with human society and its activities. It presents a rational picture of man and Nature; but what concerns us now is that the relationships which in the synthetic view should be cardinal, are but fractional. The elements exist in themselves, and they get on very well without being related. Synthesis in fact is a deliberate and consciously applied process, not one which operates in virtue of the coincidence of distributions.

Again, we may say that the physical map is the foundation of regional analysis, that certain results follow from given terrestrial forms; but there is nothing inevitable in any particular set of circumstances, and differences in effect may be more striking and significant than identities. The result of generalizing as to relations from specific examples is analogous to seeing the wood without perceiving the trees. Climate and vegetation regions there may be; but the real interest and importance often lies in the differences in superficially identical distributions. Grasslands may look all alike on the vegetation map, but they are not so in reality. The transformation of the Argentine pampas by artificially sown grasses is not represented on most maps in current usage.

Geographers seem to spend an inordinate amount of time in the classification of phenomena, and the atomization of regions in particular seems to have reached to ridiculous lengths. The 'natural region', once so fundamental as the epitome of physical and human interactions, has become a wanton unloved by the many, though most are loath to abandon it. It would have been better perhaps to leave it in its original literal sense as a Nature-made region as distinct from the cultural region which bears the impress of human activity. At any rate, hunting down regions as an end in itself has gone far enough. At best they are just frameworks, and what really matters is what is built into them.

A word may be said here about what might be termed 'map idolatry'. The map has been the sheet anchor of the geographer. There is a curious belief that it is a basic element, and that everything begins and ends in a map. Now maps are often as beautiful as they are useful, but even the best of them is merely a symbolic representation of selected facts. They are built up of layered distributions which are necessarily incomplete. A map leaves out much more than it can ever contain, and a great deal has to be read into it before it can mean very much. In short it is an auxiliary, not a fundamental element. It is a mistake to suppose we can base a serious study on empirical documents. A map is to the geographer what the time-chart is to the historian, merely a convenient method of setting out a proportion of the facts, not an original source material, for it is already a synthesis.

If the geographer still clings to deterministic frameworks, it may be claimed that he has escaped from causality. It is true that a rather vague 'possibilism' of Gallic origin has been substituted—influences replace conditions. So far the change in emphasis has not produced any great revolution, and text-books and the man-in-the-street still argue causally on environment. Yet the dominance of man as a geographical agent is obvious. His intelligence, if not always his wisdom, is at work, and he has altered the face of Nature so much that a cultural has replaced the Nature-given pattern. Examples are abundant. Railway and road construction, airways and shipping lanes, irrigation, the transplanting of crops and resources, plant genetics, and so forth. The rape of the earth may be only one side of the story; but at least it is evidence of human energy and activity.

What emerges is that the whole traditional approach to geographical questions needs revision, in that conventional geography still assumes man as an effect and not as a cause. Since palæolithic times man has never left the terrestrial scene, and both Nature and man are dynamic forces, and in a general sense man has been historically the dominant partner.

Any human group and any area may be said to be affected by two elements. One is made up of the internal and local influences operating by direct contact, and the other comprises all those external agencies which may be local or world wide, and which may or may not be more potent than those native to a given group or area. In contemporary society the 'home geography' is more and more a reflection of wider impacts which are breaking down isolation and modifying local characteristics. This species of universal leavening is, of course, a slow process, no doubt desirably so, and the universal pattern is much less well defined than local regional features at the moment. Yet this, too, carries with it the implication that human forces and actions have wrought and are still working transformations which demand a new approach to geographic studies. If, as has been implied, man throughout history has modified the natural landscape and given it ever-changing influences, it follows that the geography of the past, apart from physical changes, must be largely the record of his activities. Here is the true historical-geography, and most of that has yet to be written. This evolutionary aspect of environment, changing in substance and in incidence, is a matter of history, a 'natural history', with its central theme the place of man, creative man, in the development of the natural world.

"Geography is about maps, history is about chaps", so the schoolboy is reported. Discussions about the relations of history and geography, the meaning of historical-geography, and so on, have been held frequently, but as yet the bridge between the two subjects is still to seek. The study of a border-line marginal area necessarily makes difficult the fixing of limits. Framed as is our academic practice within a group of 'subjects', there seems no place for the historian-geographer or the geographical-historian. He should be obviously a free agent, free to draw on historical and geographical matter with whatever emphasis truth seems to require. He should not have to argue the historical factor in geography or the geographical factor in history according as to whether he is in the historical or the geographical camp. In practice he has to live and must perforce line up with one or other of the recognized 'subjects'. The divorce of man and the *oikumene* as subjects of study has resulted in the cleavage we now see. The pre-historians and the archæologists at the moment seem to be most successful in the handling of the dual theme. Too much of what passes as historical-geography suffers by the separation of bones and flesh. The historian is too often content with an introductory chapter and ignores the fact that his 'stage' is there all the time, and the scenes change, while the geographer it might be said is too interested in the decking and stage 'props' to notice much difference in the actors. There is an aridity which results from the isolation of physical and material factors as subjects of study apart from their human setting. It is man who gives them the stature that they have.

The major function of geographical study is to delineate the features of the contemporary world, and while the present has its roots in a past, and is not intelligible without some reference to that past, there is a justifying substance in contemporaneity. Things happen somewhere now as well as then. When the servant girl in Mr. Coward's play asks "Where is Africa?" her query expresses very well our general attitude to strange places. For most people acquaintance with the world about us is embodied in a cartographical outline dimly recollected from schooldays, with some detail here and there perchance remembered, but no catholic knowledge of the living societies, modes of activity and organization which function inside the framework. Geography in general education covers that area of knowledge which is concerned with international questions, political and economic features, trade and communications, and the exploitation of resources. An understanding of the nature of an integrated world order, a society of elements separate and self-contained but forced into contacts and relationships—this seems an obvious need. The older latitudinarian treatment of political and economic geography might well be revived to offset our current practice of putting everything into the regional pot. Here again the difficulty is in determining what is specifically geographical and what is not, and the question arises also as to the desirability of separating out an aspect which may only have significance in its relation to more directive and active forces. What is wanted both in the regional analysis and in the broader studies on a world basis is, so to speak, less anatomy and more physiology, less of structures and more of functions. The world is a going concern and its mechanism is in motion, while we tend to regard it as if it were at rest.

'Human geography' was a term introduced to describe all the geographical elements which were not Nature-given. It admitted man as a factor in the equation, rather grudgingly perhaps. It is a long jump from this to the latest school of geographical philosophy, that of geopolitics. Swedish in origin, this geopolitical school has found its home in Nazi Germany. It thinks of blood and soil as destiny, and its main tenet is that State, race, and land must be regarded as an organic whole, as a metaphysical entity in which the citizens exist only in and for it, while at the same time it is more than the sum of the nationals who compose it. This spurious pseudo-science is in the Ratzel tradition, and we are right back at determinism again. It is the concept of *Lebensraum* which justifies the essential geographical basis of this ideology, for terrestrial expansion of living space is a concomitant of it. The best that

can be said of this warped and distorted philosophy is that man is given a more potent if not a higher place than in some other terrestrial philosophies.

The recent revival of mechanical conceptions of society are perhaps a reflexion of the instability and lack of conscious political purpose of a world society in which economic factors and modes of physical contact are establishing a new segregation of population, and in which time-distance has so largely replaced linear distance.

If there is any validity in these reflections on the present condition of geographical study, it becomes evident that some changes in principles and methods are called for. The restoration of man and his mind to their proper sphere as purposive and active elements rather than passive agents, is beginning to appear in some kindred sciences such as physics and biology. Dr. Isaiah Bowman has written of the "timeless creative experiments" which man is participating in, and geography as one of many forces which are involved in it. Man appears in the world but is not altogether of it. As a tool-using animal he gave expression to powers and forces not hitherto known to Nature, and if he remains still part of Nature he carries some evidences of spiritual resources which Nature may utilize, but she cannot endow him with them. Let the argument start from the spiritual ancestry of man rather than from his animal origins, put human will and aspiration and effort first, and the terrestrial domain second—it is after all underneath our feet if we stand up—and the old premises which have clamped us down so long must vanish, and maybe a new birth will be given to a most ancient part of knowledge.

MARINE ANIMAL OILS OF CANADA

By Prof. T. P. Hilditch

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THE varied and abundant fauna of the rivers of Canada and especially of the Atlantic and Pacific Oceans on the eastern and western shores of the Dominion form an important section of its natural resources. Canadian salmon, pilchard and cod are well-established edible commodities, but it is perhaps less widely known that in recent years the Canadian production of fatty oils from the flesh, livers, or other specific parts of certain fish and marine mammals has greatly expanded, whilst the quality of the oils is generally of a high standard owing to the increasing use of plant and conditions of extraction in accordance with the results of modern research on the chemical and technical properties of marine animal oils.

Up to the present the fish oils which have been most largely produced in Canada are from pilchards, herring, salmon, cod and halibut. Pilchard and salmon oils are extracted in quantity on the Canadian Pacific coasts, herring oil mainly on the Pacific, but also on the Atlantic shores, whilst halibut is taken from both oceans, and cod mainly but not entirely from the Atlantic side. The total annual fish-oil production of British Columbia varies from 2·5 to 4 million gallons per year, of which pilchard oil usually provides 1·5–2·5 million gallons; the Canadian annual production of cod liver oil of all grades is usually more than 150,000 gallons, although this is only 25–35 per cent of the amount of this oil produced in Newfoundland. There are, however, oils from a large number of other species of fish—coalfish, rockfish, rays, grayfish, ratfish and others as well as the more familiar ling, hake, mackerel or haddock—from which fatty oils could be produced in quantity. Again, more than 500,000 gallons of whale oil are made annually from whales taken off British Columbia; nearly half this output is from sperm or toothed whales, the rest from the baleen whales; seal oil is obtained in less amount (50,000–70,000 gallons per year) on the Atlantic coasts, and porpoise and dolphin oils, although not in much demand, could be obtained in quantity since these members of the Delphinidæ are plentiful off all the coasts of Canada.

Marine animal oils differ to quite a large extent in composition, although there are fundamental similarities in the kinds of fatty acids present in the form of glycerides or wax esters. Those of the cod or halibut liver, herring, salmon or baleen whale flesh, and many others are all comparatively similar, especially in containing major proportions of glycerides of highly unsaturated fatty acids with 20 or 22 carbon atoms in the molecule; but even in this group there are well-marked differences in the general proportions of the component fatty acids which seem to be mainly determined by species—perhaps also by dietary and other factors. Some of the other oils which have been mentioned differ more radically in chemical composition. Those of the sperm whales are largely wax esters and not esters of glycerol, the alcohols in combination with the mixture of fatty acids being largely cetyl, $C_{16}H_{33}(OH)$, and oleyl, $C_{18}H_{35}(OH)$. Ratfish liver oil seems to consist to a very large extent, not of glycerides, but of fatty acid esters of complex ethers of glycerol with a higher fatty alcohol. The Delphinidæ oils contain large amounts of *iso*-valeric acid in conjunction with the more usual kind of higher fatty acids, in the form of mixed triglycerides. It is natural that such variation in composition should afford scope for a variety of technical uses.

Probably, however, the most interesting of the fish oils at present are those which are found to be exceptionally rich in the fat-soluble vitamins. Halibut liver oil and, still more, the visceral oil, are well known in this connexion, but this is by no means the only instance. The production of exceptionally vitamin-rich fish oils, which serve as a valuable source of vitamin-A concentrates for incorporation in edible fats, is one of the most important fish-oil industries to-day. Although unsuitable *per se* for margarine or soap manufacture (by reason of odour and of proneness to atmospheric oxidation), fish oils and, more particularly, baleen whale oils, are converted by hydrogenation into more stable fats of high quality. But a number of other uses have been found for these oils, some of which may be less familiar. In contrast to their nutritional values, fish oils and their soaps

find considerable use as toxic agents in insecticides, especially in fruit growing; the applications of these oils in the leather and textile industries are probably better known than the growing use of hydrogenated fish oils in the manufacture of tinplate; they can be transformed into rubber substitutes as well as into varnishes or linoleum.

The wide range of utility of the marine animal oils, potential as well as actual, is extremely thoroughly covered in a recent Bulletin edited by Dr. Brocklesby*; but the work can be commended for other reasons which will appeal to readers of NATURE. Instead of being limited to the purely technical aspects, the discussion of the latter is based entirely upon the fundamental chemical and physical properties of the fats, which are dealt with so adequately that the book forms a remarkably complete guide to the chemistry of fats as a whole. Moreover, the component acids and glycerides of the marine animal oils are considered in the light of modern research in this field (to which the chemists of the Pacific Fisheries Experimental Station have made their own contributions) and not solely with reference to the technically useful, but otherwise often uninformative, 'analytical characteristics' such as iodine values, specific gravities, etc.

The late Sir William Hardy, first director of Food Investigation of the Department of Scientific and Industrial Research, planned that the work in his research stations should involve equally the technical applications of science and the fundamental principles underlying these applications—a tradition which is still followed by the Food Investigation Board. It is evident that the balance between 'pure' and 'applied' science is similarly maintained by the Canadian Fisheries Research Board; in consequence the monograph now published will be read with as much interest and benefit by other scientific workers as by the technologists for whom it is primarily intended.

* The Chemistry and Technology of Marine Animal Oils with particular reference to those of Canada. Bulletin 59 of the Fisheries Research Board of Canada. Edited by Dr. H. N. Brocklesby (Chief Chemist, Pacific Fisheries Experimental Station, B.C.). Pp. 442+74 figures. (Ottawa: Fisheries Research Board of Canada, 1941.) 2.95 dollars (paper), 3.80 (cloth) net.

ELECTRIC HEATING OF BEEHIVES

THE British Electrical and Allied Industries Research Association has issued a preliminary report, by its director and secretary, Mr. E. B. Wedmore, describing experiments on the heating of beehives*. It also describes the construction and preliminary testing of certain units for keeping beehives at any required temperature. Tests are to be made shortly at the Rothamsted Experimental Station under working conditions on a large scale.

In Nature, the heat required by a colony of bees is produced by the consumption of honey. This is an expensive fuel, and might be helped out and controlled to advantage by the use of electricity. Many observations of temperatures within the hive in relation to the life and requirements of the bee have been made, and the craft has turned in the direction of controlled heating of hives. The aim of the present report is to bring the problem into perspective and to record some preliminary observations on effects within the hive of changing external temperatures and conditions, and of the use of certain heating units.

In obtaining figures of convenient magnitude, and in considering electric heating, it is convenient to measure all energy in electrical terms. The complete combustion of 1 lb. of an average honey with an average water content represents two watts for one month, and honey in the hive may be taken as being worth 6*d*. per lb. (If removed, extracted, strained, bottled, packed and carted, it may be worth, say, 1*s*. 4*d*. wholesale.) Thus the production of heat by the complete combustion of honey costs 3*d*. per watt per month if the efficiency is 100 per cent. The heat is, in fact, produced by the bees deliberately performing mechanical work, and while the oxygenation is probably fairly complete, there is wear and tear to be made good as well as shortening of the bees' life, so that the actual cost per watt per month to the beekeeper must be higher, but most probably less than twice 3*d*.

If sugar is used, the heat of combustion is about doubled, but if reduced to syrup by adding water, this additional water content has to be dealt with. The physiological loss is greater and the syrup has to be prepared. Taking the sugar syrup at 6*d*. per lb. of sugar including labour and wastage in storing, the cost per watt per month will be between 1½*d*. and 3*d*., not allowing for maintenance of and interest on the cost of apparatus.

Electrical energy could be substituted for honey consumption only if the heat be provided at the right time, the right place and in the right quantity. Assuming 100 per cent efficiency in each case, we have then for the cost of 1 watt per month: (*a*) by consumption of honey in the hive at 6*d*. per lb., 3*d*.; (*b*) by consumption of sugar in the hive at 4*d*. per per lb., 1½*d*.; (*c*) by use of electrical energy at 1*d*. per unit, ½*d*. It is clear, therefore, that there must be some definite additional indirect gain if heating by electricity is to be justified, the cost of the equipment must be low and the technique of its use simple and efficient.

With the commencement of frosts in October, breeding is greatly reduced, and it ceases in December or earlier. Bardenbacher's tests suggest that brood raising may be advanced about three weeks by appropriate heating in the spring season, and one such advanced colony may well do the work of two. It is pointed out that in spring there are good hopes of stimulating brood raising by making it easier for the bees to maintain the requisite temperature, especially at night and in cold periods, and at the same time reduce the indirect losses caused by condensation of moisture.

Data as to the thermal properties of a hive and its contents are given. The hives are usually constructed of cedar or firs of varying quality, and some are painted. Probably reduction of forced movement of

* British Electrical and Allied Industries Research Association Technical Report, Reference W/T5: Electric Heating of Beehives—Preliminary Report. By E. B. Wedmore. Pp. 19+5 plates. (London: British Electrical and Allied Industries Research Association, 1941.) 3*s*. 6*d*.

air within the hive in really cold weather by guarding the entrance is more important than any external packing.

To obtain currents of 1–20 watts from a 230-volt circuit requires resistances which, if wire-wound and suitably insulated, are relatively costly. On the other hand, two miniature lamps of suitable rating in series will give results of the right order at a moderate cost with reasonable life, and will admit of wiring a number of hives in parallel off a mained loop from hive to hive.

The hive used for preliminary experimental work consisted of a standard National body on a base with deep cover, a 6-in. lift being used to carry the heating units and packing so that the deep cover just overlapped the top of the body box. The hive was located in a well-ventilated wooden shed to protect it from winds. In certain tests a small fan was used to blow a stream of air at a speed of about 12 m.p.h. diagonally at the entrance. The hive used represents roughly the minimum size of stock hive that would be employed for wintering in Great Britain.

It has been shown that a small increase in the difference between the internal and external temperatures of the hive has a useful effect in reducing condensation and consequent dampness. Two periods have to be considered, namely, the quiescent period and the early brood-raising period. The useful applications already made belong to the early brood-raising period; the difficulties met with are mainly difficulties of control.

Twenty-four heating units are being built for Rothamsted Experimental Station, where they will be used with and without thermostatic control during next winter.

FORTHCOMING EVENTS

Monday, May 5

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. G. Stafford Whitby: "Chemotherapy", II.

BRITISH PSYCHOLOGICAL SOCIETY (at 55 Russell Square, London, W.C.1), at 1.20 p.m.—Mrs. Winifred Raphael: "War-Time Grouses in Industry".

Thursday, May 8

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 2.30 p.m.—Prof. S. Chapman, F.R.S.: "Electrical Works by Helios, or The Sun and the Ionosphere".

Friday, May 9

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. E. N. Bromehead: "The Early History of Mining".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

TEACHER OF ENGINEERING WORKSHOP PRACTICE AND/OR WOODWORK AND DRAWING, and a TEACHER OF MATHEMATICS AND SCIENCE, at the Mexborough Schofield Technical Institute—The Secretary to the Managers, Education Office, Mexborough, Yorks. (May 10).

SENIOR ASSISTANT MASTER TO TEACH SCIENCE AND MATHEMATICS at the Sparkhill Commercial School—The Chief Education Officer, Higher Education Department, Education Offices, Council House, Margaret Street, Birmingham 3 (May 12).

PRINCIPAL of the Shrewsbury Technical College—The Secretary, for Education, County Buildings, Shrewsbury (May 21).

PROFESSOR OF MECHANICAL ENGINEERING—The Registrar, University of Sydney, Sydney, N.W.S., Australia (June 1).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. War Food Production Advisory Bulletin No. 2: Ley-Farming. By Sir R. George Stapledon. Pp. 22. (Aberystwyth: Welsh Plant Breeding Station.) 1*s.* [313

Spectrochemical Abstracts. Vol. 2, 1938–1939. By Ernest H. S. van Someren. Pp. 38. (London: Adam Hilger, Ltd.) [313

Scientific Proceedings of the Royal Dublin Society. Vol. 22 (N.S.), No. 37: Studies in Peat, Part 10: Activated Charcoals from Peat Residue. By Dr. Joseph Reilly and James R. O'Donoghue. Pp. 367–377. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s.* [94

Imperial Forestry Institute: University of Oxford. Sixteenth Annual Report, 1939–40. Pp. 18. (Oxford: Imperial Forestry Institute.) [94

Thirty-eighth Annual Report, 1940–1941, of the Imperial Cancer Research Fund. Pp. 34. (London: Royal College of Surgeons.) [96

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 1, No. 4: On an Elementary Solution of a Partial Differential Equation of Parabolic Type, Part 1. By E. T. Copson. Pp. 37–53. 1*s.* 6*d.* Vol. 61, Part 1, No. 5: On an Elementary Solution of a Partial Differential Equation of Parabolic Type, Part 2: The Nature of the Singularity. By E. T. Copson. Pp. 54–60. 6*d.* (Edinburgh and London: Oliver and Boyd.) [224

Town and Country Planning Association. Forty-second Annual Report. Pp. 8. (Welwyn Garden City: Town and Country Planning Association.) [224

British Trust for Ornithology. Seventh Report, for the Year 1940. Pp. 12. (Oundle: British Trust for Ornithology.) [244

Other Countries

Imperial Council for Agricultural Research. Scientific Monograph No. 14: Further Studies on Cereal Rusts in India. By Dr. K. C. Mehta. Pp. vii+224+12 plates. (Delhi: Manager of Publications.) 6 rupees; 9*s.* 6*d.* [313

Union of South Africa: Department of Agriculture and Forestry. Pamphlet No. 222 (Chemistry Series No. 163): The Inoculation of Clover. By W. B. Goldschmidt and Dr. E. R. Orchard. Pp. 8. (Pretoria: Government Printer.) 3*d.* [24

Carvão de Santa Catarina. Relatorio a presentado em 1890 a o Governo da Republica pelos Luiz F. Gonzaga de Campos, Fabio Hostilio de Moraes Rego, João Caldeira d'Alvarenga Messeder. Pp. 91. Duas Notas sobre os Cimentos Nacionais—a Magnesia—os 'Compostos' do Cimento. Pelo Paulo Sá. Pp. 39. A industria e o Laboratorio: o auxilio dos Laboratorios às Industrias de Construção. Pelo Paulo Sá. Pp. 32. A especificação Brasileira para Cimento Portland e as tendências modernas sobre o assunto. Pelo Paulo Sá. Pp. 28. Metalografia das Ligas de Aluminio: aluminio-ferro. Por E. Orosco e Heiens Brandão Orosco. Pp. 16+12 plates. Estabilização de solos. Pelo Paulo Sá. Pp. 51. (Rio de Janeiro: Instituto Nacional de Tecnologia.) [94

Anuario del Observatorio Astronómico de Madrid para 1941. Pp. 300. (Madrid: Instituto Geográfico.) [84

Colony of Mauritius: Department of Agriculture. Tenth Annual Report of the Sugarcane Research Station for the Year 1939. Pp. 48. (Mauritius: Government Printer.) 70 cents. [84

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 51: Technological Reports on Trade Varieties of Indian Cottons, 1940. By Dr. Nazir Ahmad. Pp. vi+107. 1.8 rupees. Technological Bulletin, Series A, No. 52: Technological Reports on Standard Indian Cottons, 1940. By Dr. Nazir Ahmad. Pp. iv+110. 1.8 rupees. (Bombay: Indian Central Cotton Committee.) [84

Memoirs of the National Academy of Sciences. Vol. 23, Third Memoir: Observations and Measurements on the Members of the National Academy of Sciences. By Aleš Hrdlička. Pp. x+106. (Washington, D.C.: Government Printing Office.) 30 cents. [114

Smithsonian Miscellaneous Collections. Vol. 99, No. 19: Notes on Mexican Snakes of the Genus *Geophis*. By Hobart M. Smith. (Publication 3629.) Pp. ii+6. Vol. 99, No. 20: Further Notes on Mexican Snakes of the Genus *Salvadora*. By Hobart M. Smith. (Publication 3630.) Pp. ii+12. (Washington, D.C.: Smithsonian Institution.) [114

Punjab Irrigation Research Institute. Report for the Year ending April 1939. Pp. v+7+189+102 plates. Research Publication, Vol. 2, No. 24: Experiments for the Haveli Project on a Model of the Rivers Jhelum and Chenab Downstream of their Confluence. By Dr. N. K. Bose and L. Thakar Dass Gulati. Pp. 58+27 plates. 1.8 rupees. Research Publication, Vol. 2, No. 25: Experiments for Silt Control on a Model of the Emerson Barrage, Left Undersluices, Left Regulator, with a Part of the River Chenab Upstream. By Dr. N. K. Bose and Thakar Das Ghulati. Pp. 12+26 plates. 6 annas. Research Publication, Vol. 3, No. 4: The Formation and the Reclamation of Thur Lands in the Punjab. By M. L. Mehta. Pp. 54+17 plates. (Lahore: Government Printing Office.) [164

Canada: Department of Mines and Resources: Mines and Geology Branch, Geological Survey. Paper 40–15: Preliminary Map, Grave Flats, Alberta. By B. R. MacKay. 10 cents. Paper 40–16: Preliminary Map, Pembina Forks, Alberta. By B. R. MacKay. 10 cents. Paper 40–19: Preliminary Map, Bearberry, Alberta. By H. H. Beach. 10 cents. Paper 40–20: Preliminary Map, Assinica Lake, Quebec. By G. Shaw. 10 cents. Paper 40–21: Preliminary Map, Mishagomish Lake, Quebec. By G. Shaw. 10 cents. (Ottawa: King's Printer.) [174